





LES EV Study

Preparing for a plug-in future


Study Methodology


 **1** LES customer with a BEV or PHEV applied via Geotab-hosted website.

 **2** LES and Geotab reviewed applicants; targeted 50 that covered a wide range of vehicle types.


 **3** Once approved, Geotab shipped hardware device to participant.



 **4** Participant plugged in device and Geotab received cellular signal to ensure operations.

 **5** LES downloaded anonymized data each month, including:

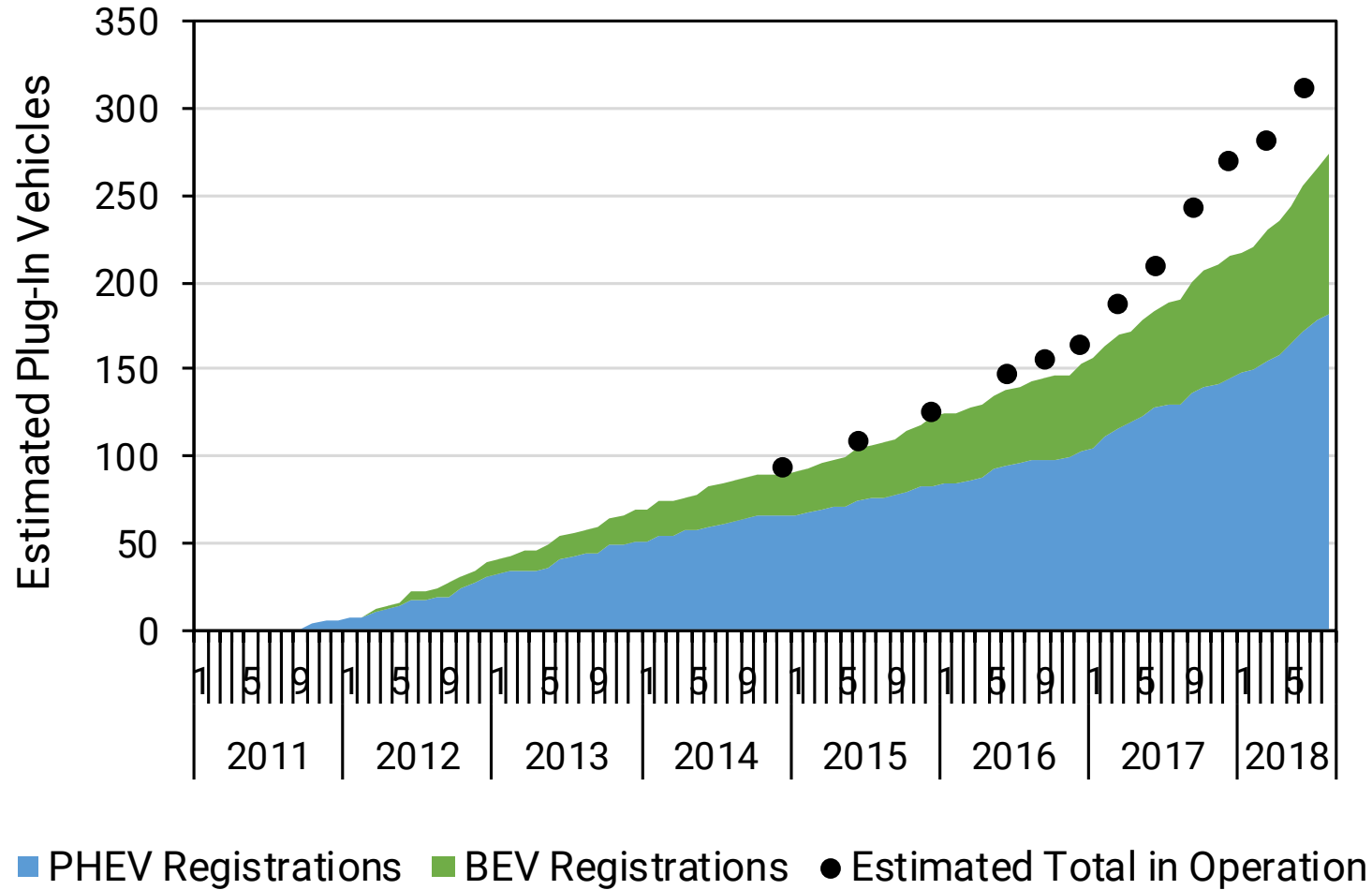
- » Charging session duration, energy use and location.
- » Trip duration, energy use, and distance.

 **6** Participant received:

- » \$25 upon data collection.
- » Easy access to personal charging/trip data via web.

Potential Participant Pool

As of August 2018 Program Launch



Customer Enrollment

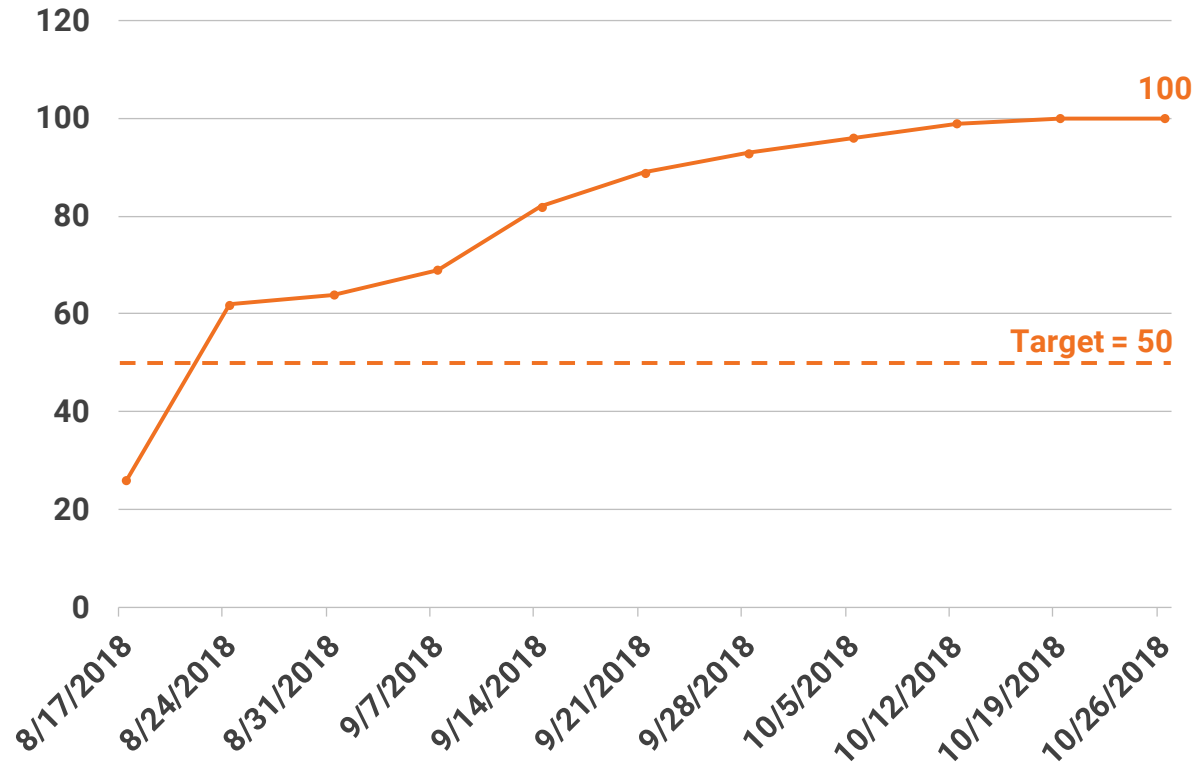
Marketing included the following:

- LES.com, social media, email, etc.
- Press release
- Radio adds
- Breakfast for “EV Champions”
- Windshield flyers



Customer Participation

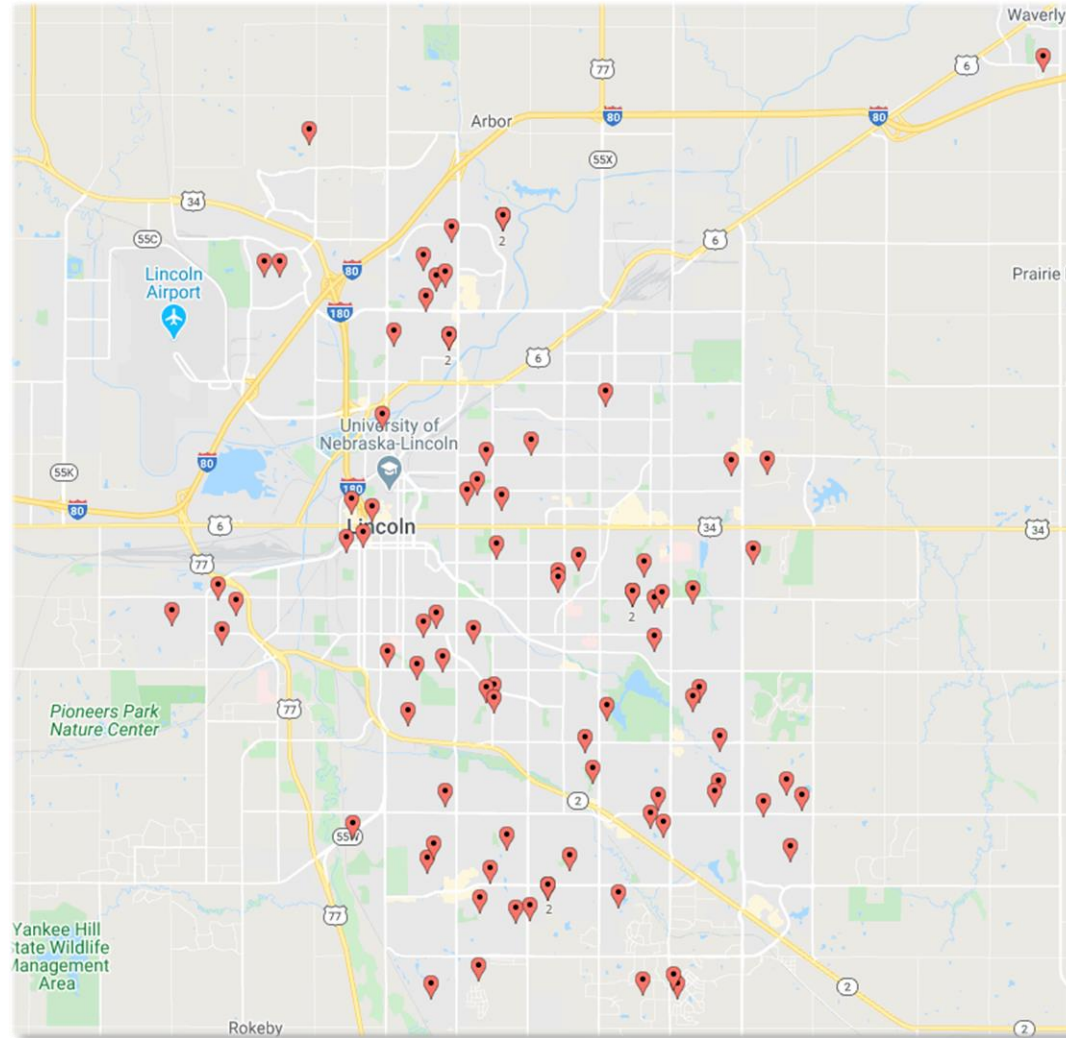
Customer Applications



2019 Participants	
Vehicle Make/Model	Number
BMW i3	3
Chevrolet Bolt	7
Chevrolet Volt	23
Chrysler Pacifica PHEV	3
Fiat 500e	1
Ford C-Max Energi	3
Ford Fusion Energi	3
Mitsubishi i-MiEV	2
Nissan Leaf	19
Smart Fortwo ED	2
Tesla Model 3	9
Tesla Model S	9
Tesla Model X	3
Toyota Prius Prime	5
Volkswagen e-Golf	1
Total	93

Customer Participation

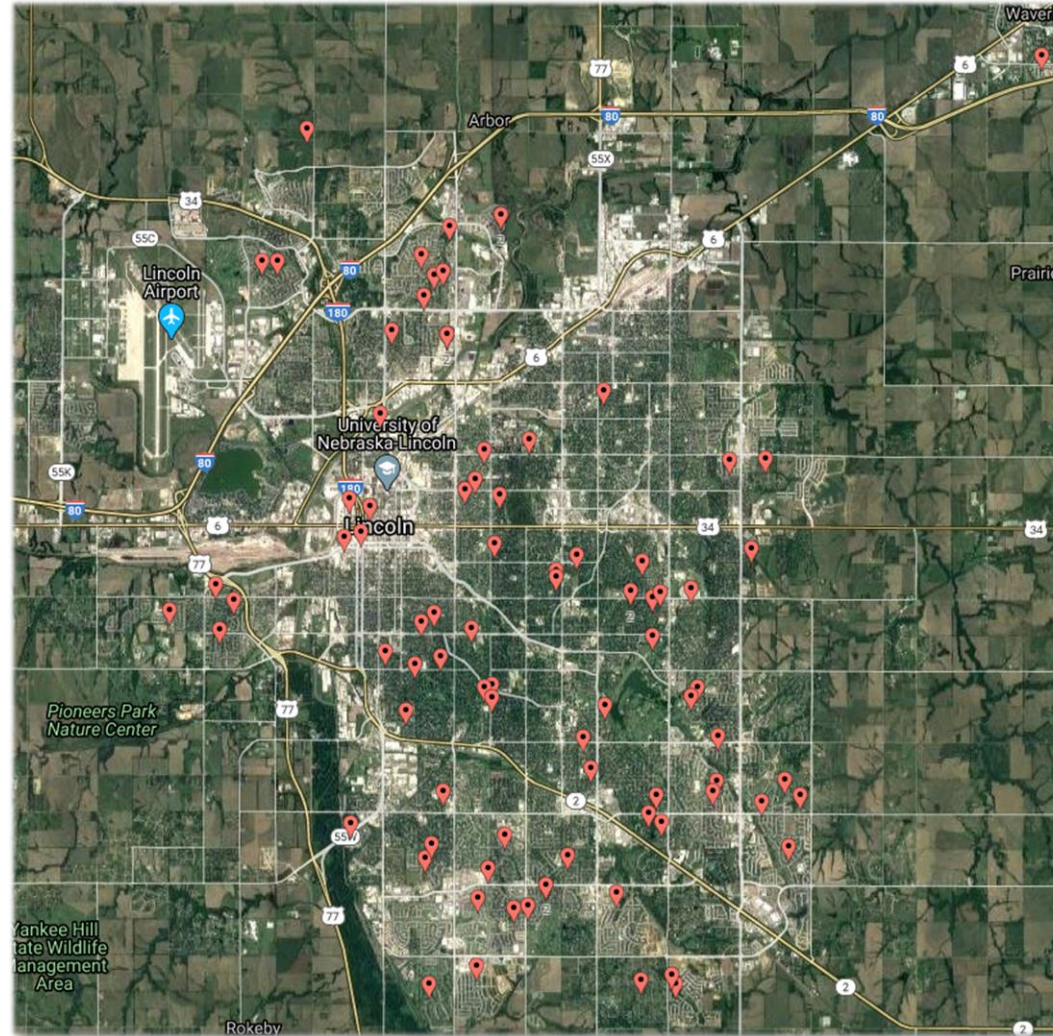
Home address



Source: BatchGeo

Customer Participation

Home address



Source: BatchGeo

Select Charging Data Points

interval_start_date

Starting date and time of charging interval. Intervals are broken in to 15-minute clock periods to easily coordinate with typical utility demand interval metering.

interval_end_date

Ending date and time of charging interval. Intervals are broken in to 15-minute clock periods to easily coordinate with typical utility demand interval metering.

charge_energy_kwh

The amount of electricity consumed during the 15-minute metering interval, in units of kilowatt-hours.

charge_energy_loss_kwh

The amount of energy, in units of kilowatt-hours, that enters the vehicle's charging port but does not make it to the battery.

max_charge_power_kw

The maximum charging demand recorded during the 15-minute metering interval, in units of kilowatts.

Select Charging Data Points

start_soc_percent

The battery state of charge, expressed as a percentage, at the start of the 15-minute metering interval.

end_soc_percent

The battery state of charge, expressed as a percentage, at the end of the 15-minute metering interval.

geofence_name

GPS-determined location of charging, including the following designations:

- Home
Charging occurred at participant's residence, identified by anonymized numbering code.
- Public charging station
Charging occurred at one of 13 pre-designated public charging stations, identified by name.
- Service area
Charging occurred within the LES service territory.
- State of Nebraska
Charging occurred within the state of Nebraska.

Select Trip Data Points

start_date

Starting date and time of trip.

end_date

Ending date and time of trip.

trip_distance_traveled_miles

The total distance traveled during the trip, in units of miles.

start_soc_percent

The battery state of charge, expressed as a percentage, at the start of the trip.

end_soc_percent

The battery state of charge, expressed as a percentage, at the end of the trip.

fuel_consumed_gal

The amount of gasoline consumed during the trip, in units of gallons.

Select Trip Data Points

energy_consumed_kwh

The amount of electricity consumed during the trip, in units of kilowatt-hours.

aux_load_kwh

The total amount of energy expended to support auxiliary systems (HVAC, radio, etc.) during trip, in units of kilowatt-hours. Based on the amount of time vehicle was idle, or had a speed of zero, and the average power expended (in units of kilowatts) during those periods.

total_electric_distance_traveled_miles

The total distance traveled during the trip solely on electricity, in units of miles.

initial_odometer_value_miles

The odometer reading at the start of the trip, in units of miles.

final_odometer_value_miles

The odometer reading at the end of the trip, in units of miles.

Select Trip Data Points

ambient_temperature_F

The average ambient air temperature during the trip, in units of degrees Fahrenheit.

combined_mpg_equiv

Equivalent mileage rate, in units of miles per gallon of gas consumed. Calculated by converting *energy_consumed_kwh* to gallons of gas, based on a conversion of 33.705 kWh/gallon. For a PHEV, this equivalent value is then added to the gallons of gasoline actually consumed during the trip.

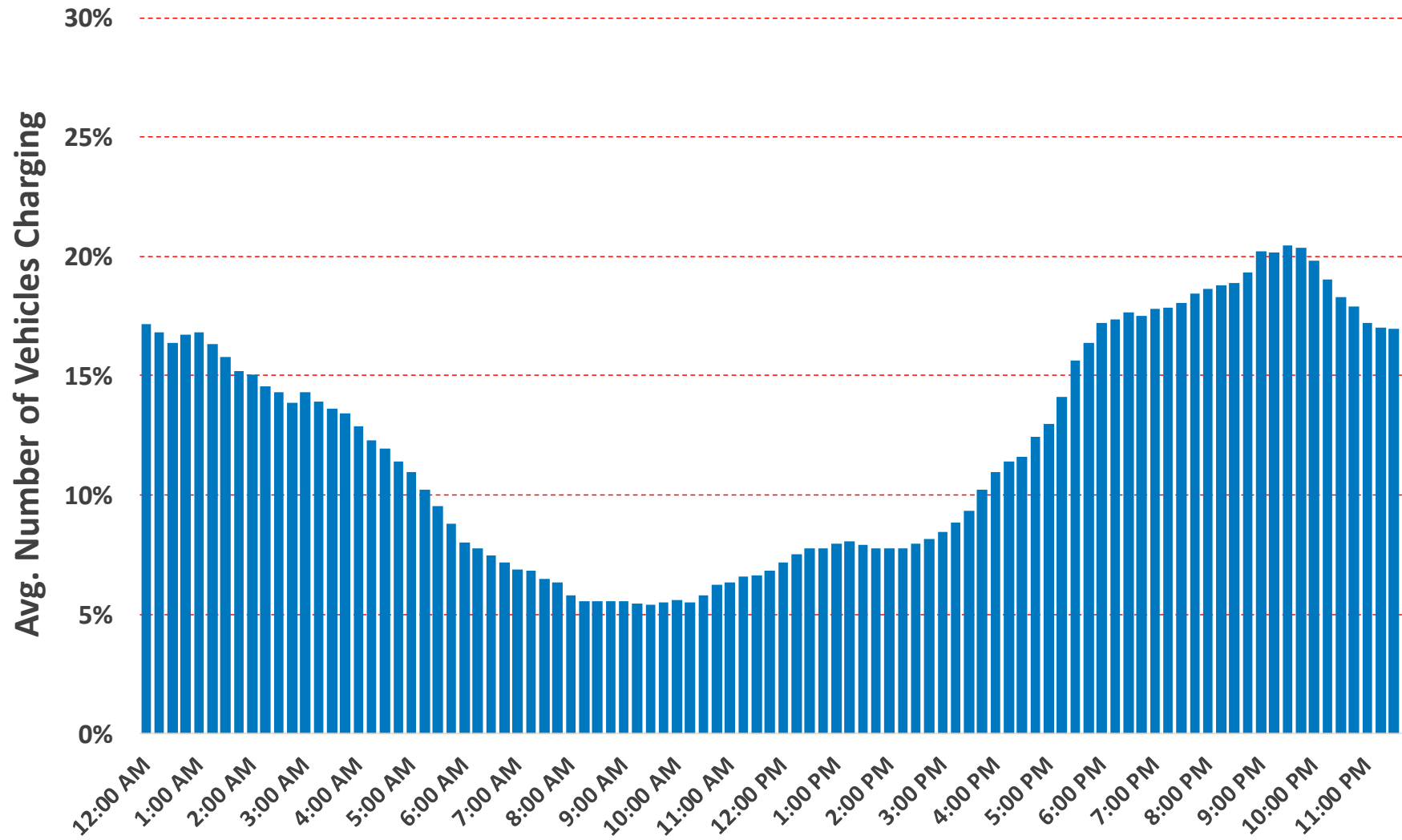
idle_time_percent

The percentage of time during the trip that the vehicle had a speed of zero.

2019 Study Results

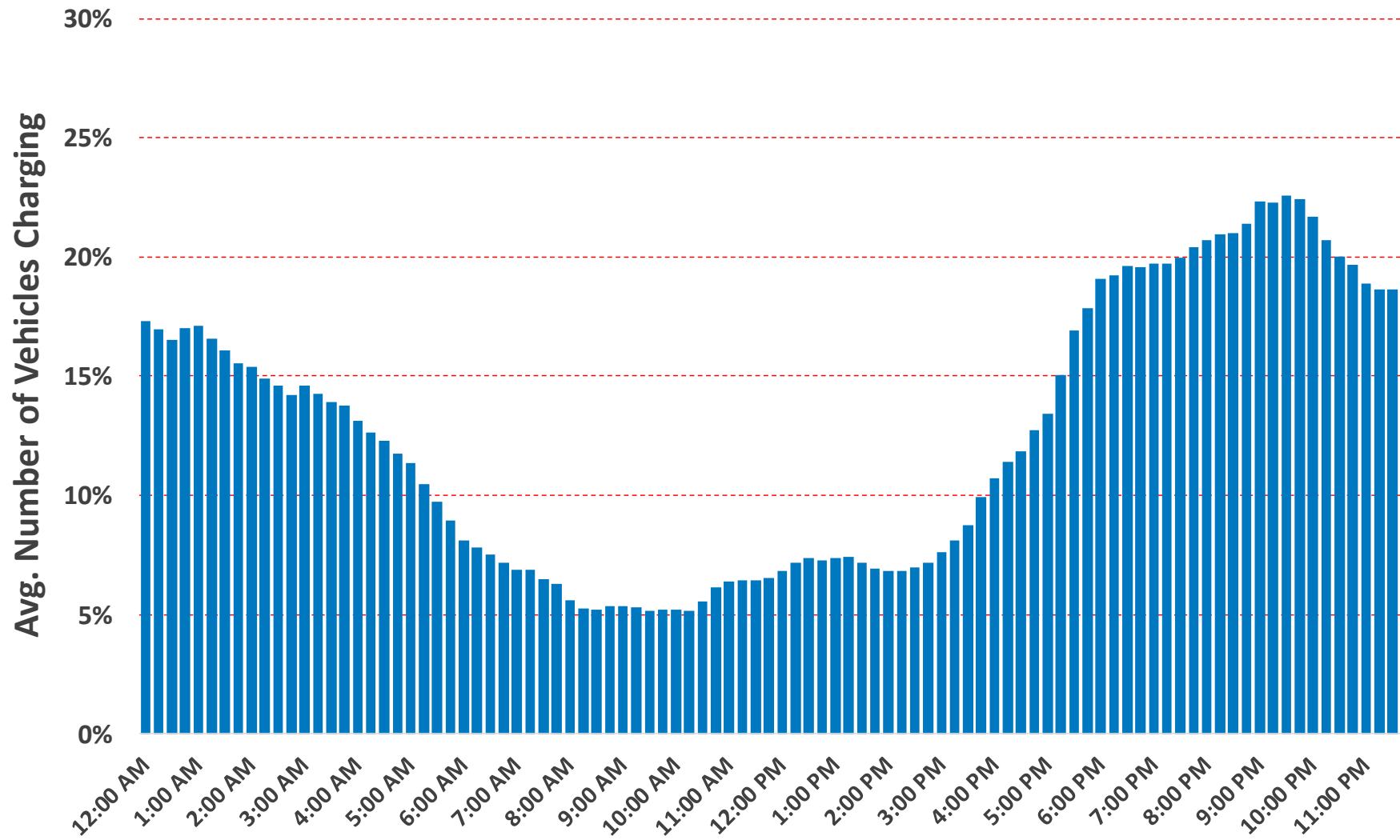
Customer Charging Data

Jan 2019 – Dec 2019



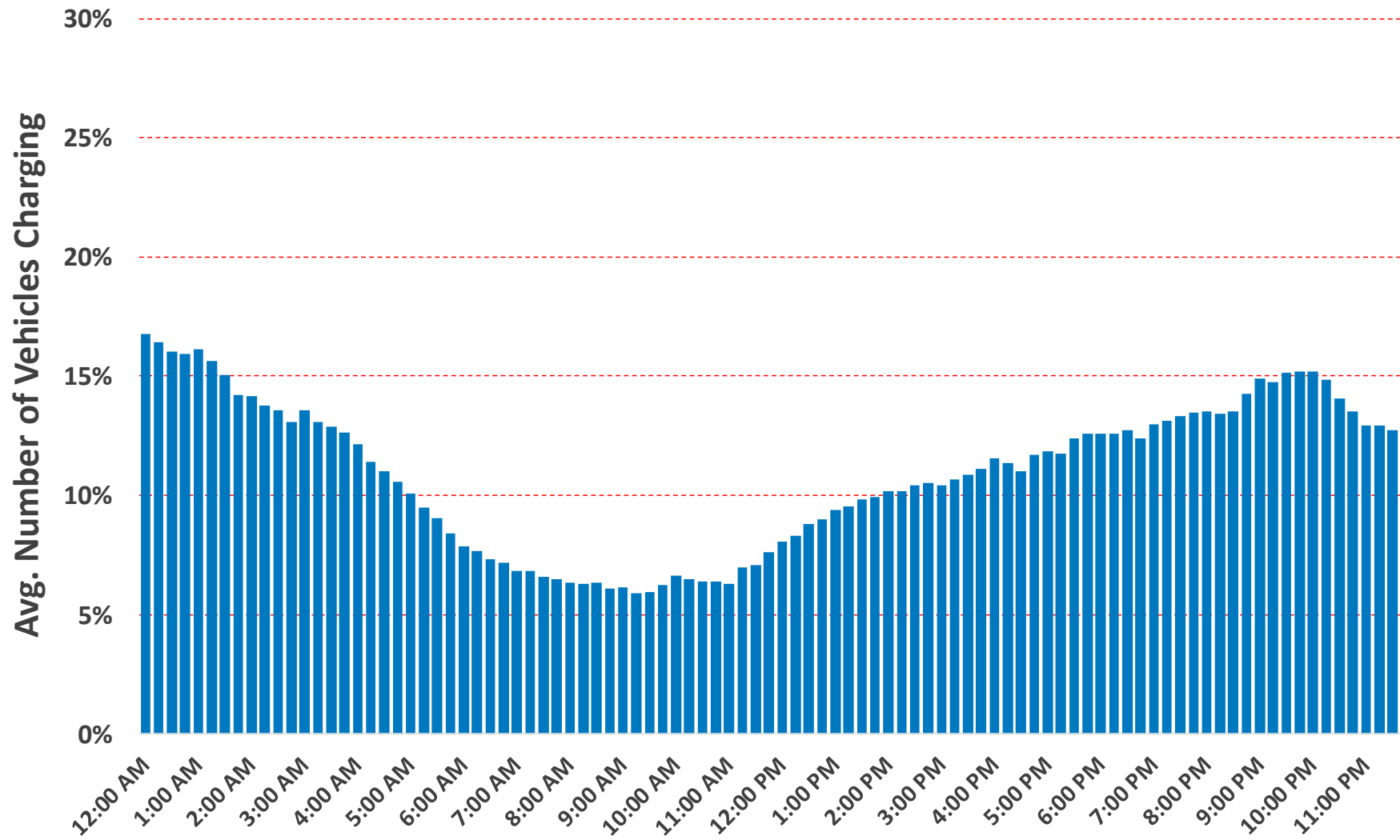
Customer Charging Data

Jan 2019 – Dec 2019, Weekdays



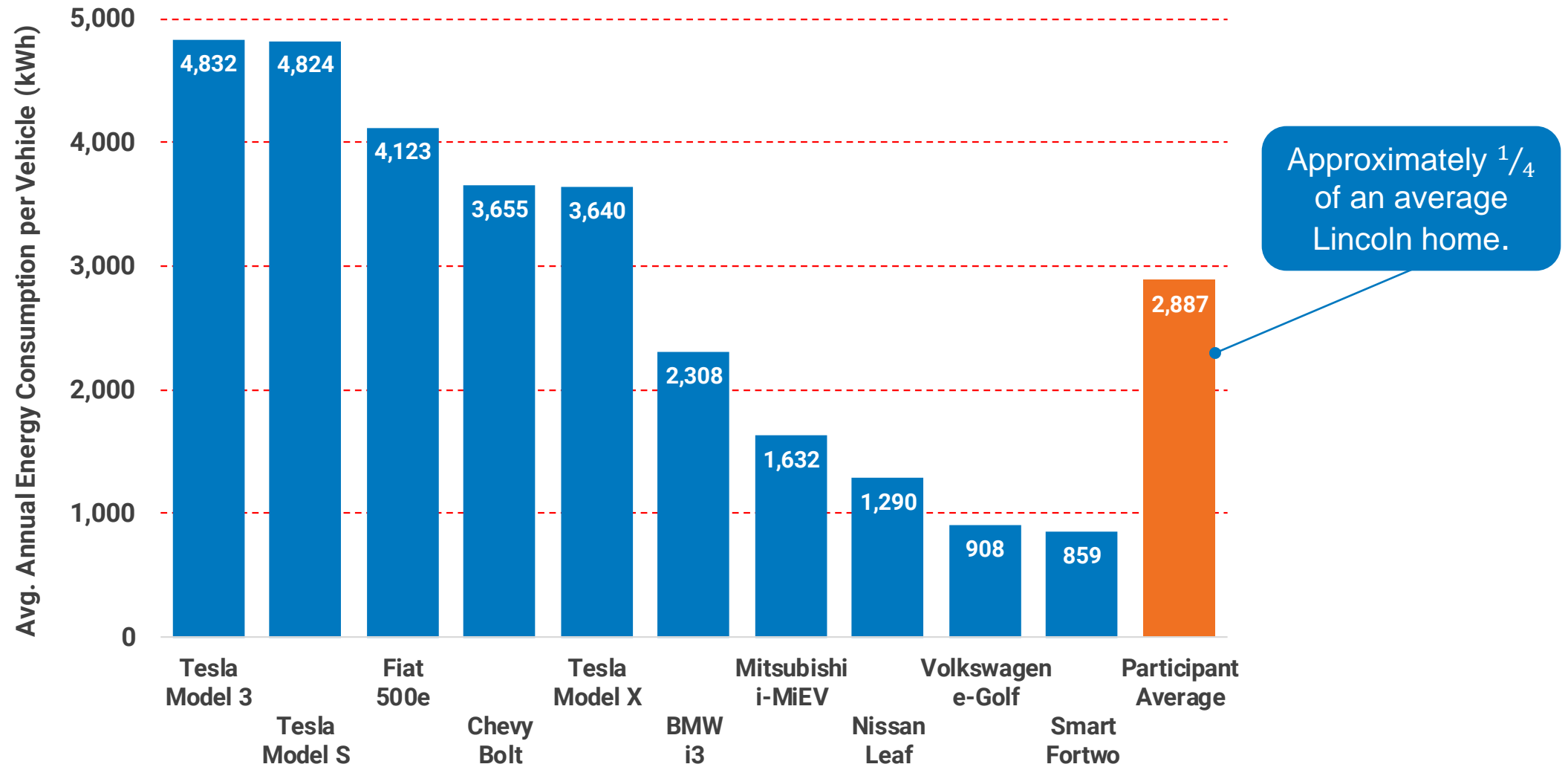
Customer Charging Data

Jan 2019 – Dec 2019, Weekends



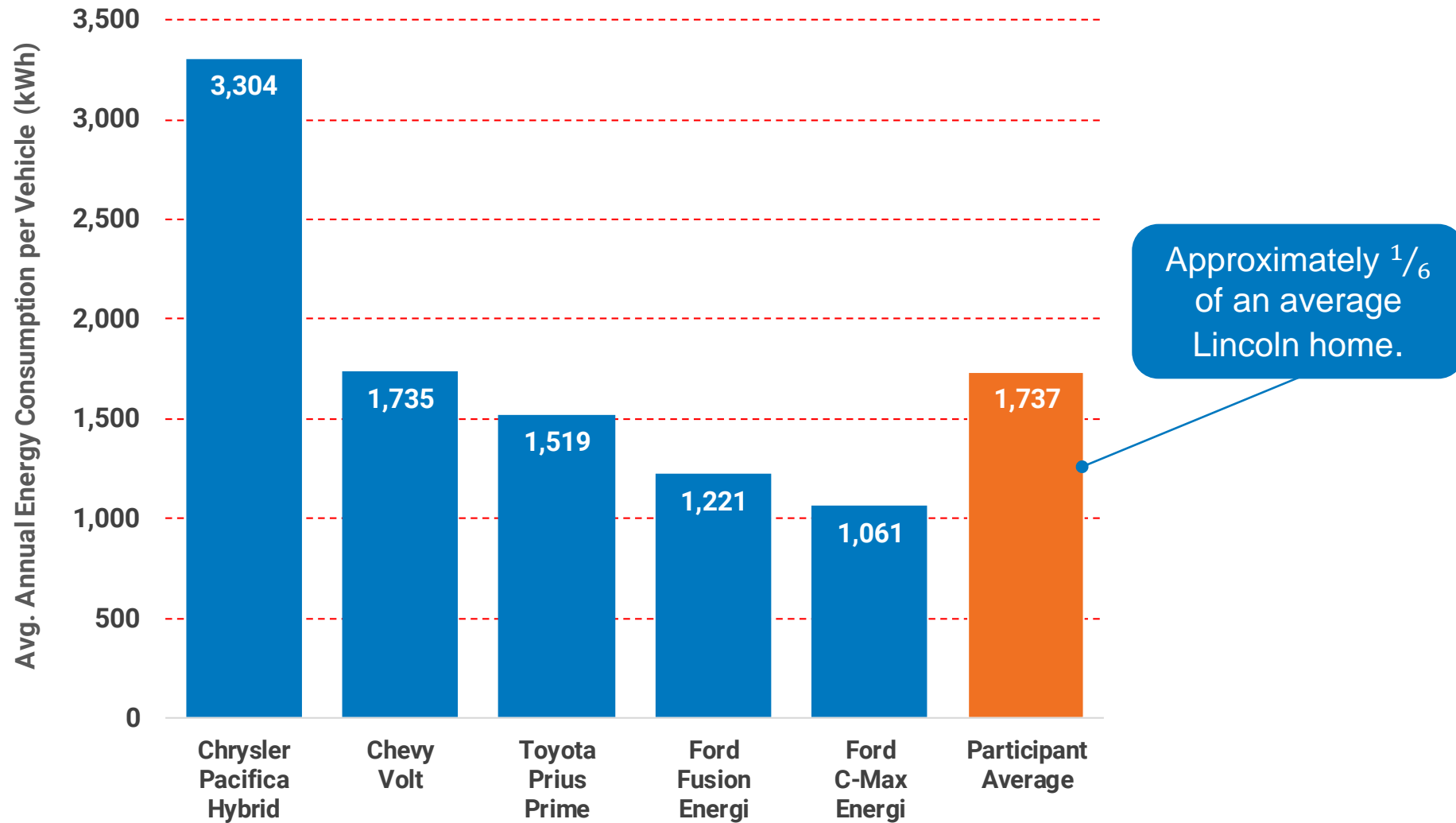
Customer Charging Data

Jan 2019 – Dec 2019, BEV



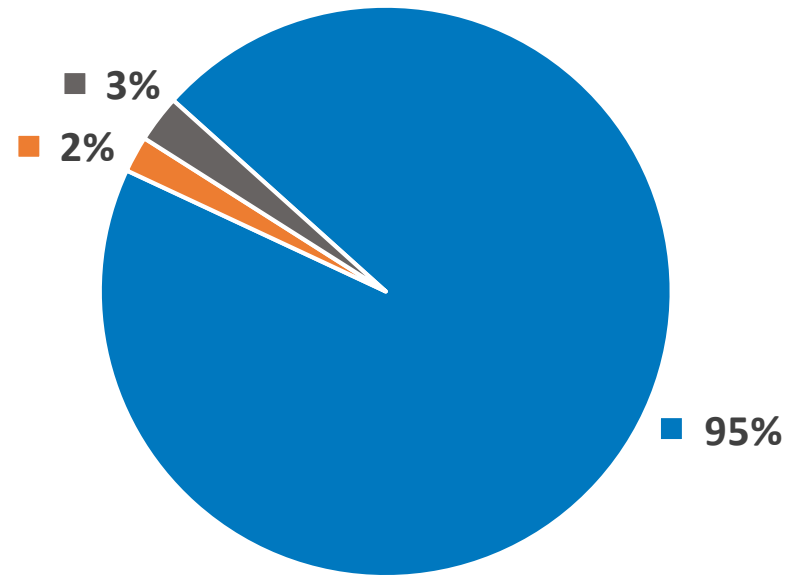
Customer Charging Data

Jan 2019 – Dec 2019, PHEV



Customer Charging Location Data

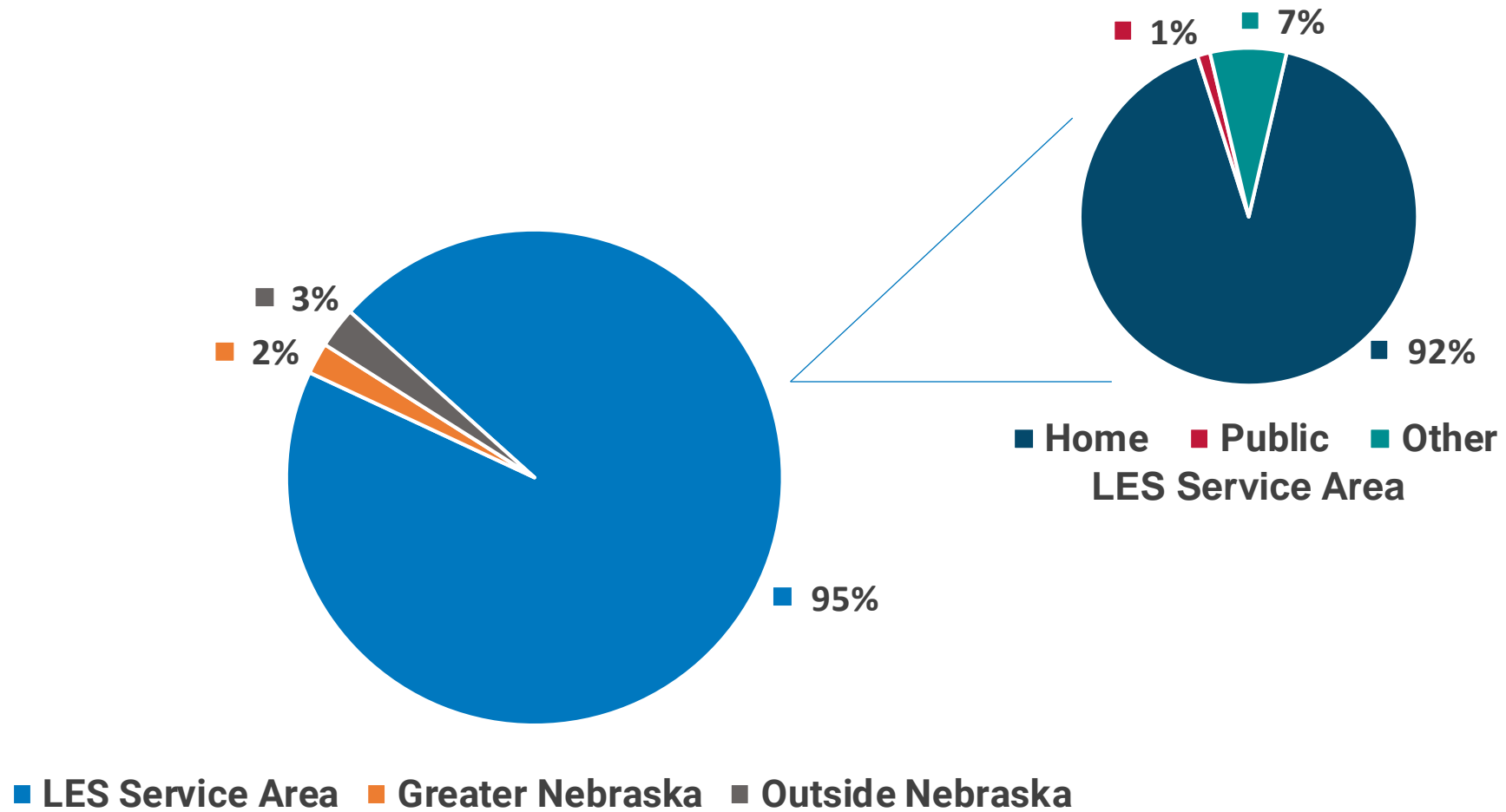
Jan 2019 – Dec 2019



■ LES Service Area ■ Greater Nebraska ■ Outside Nebraska

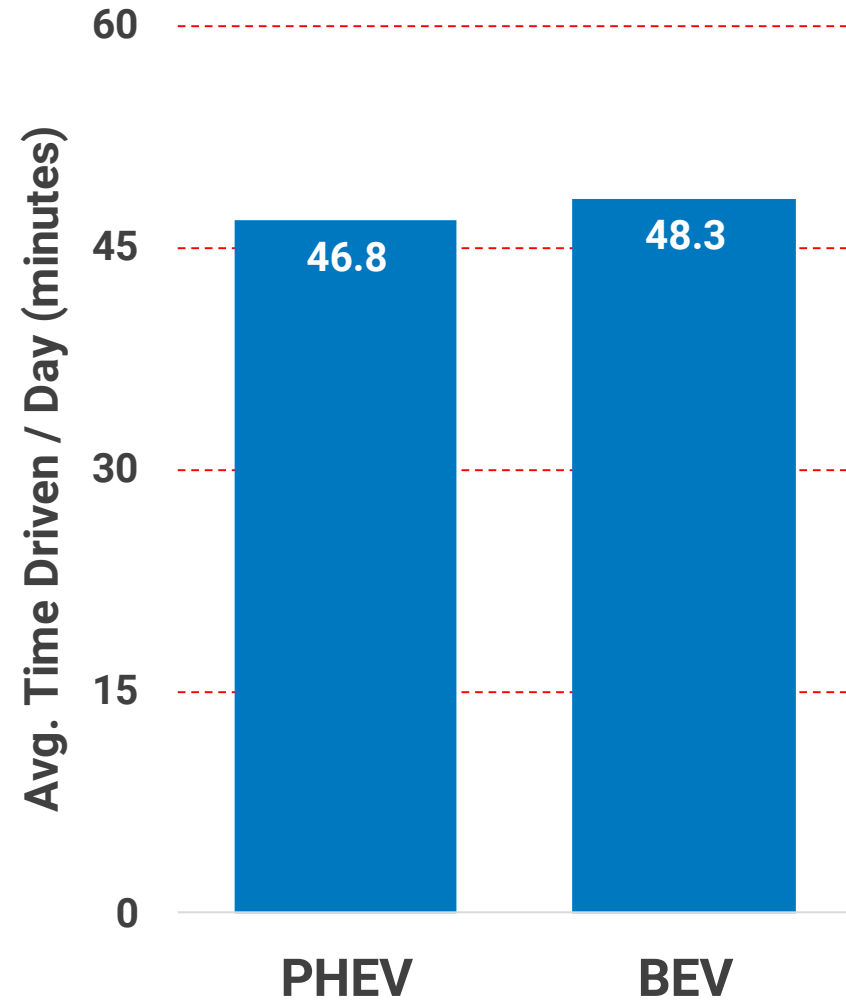
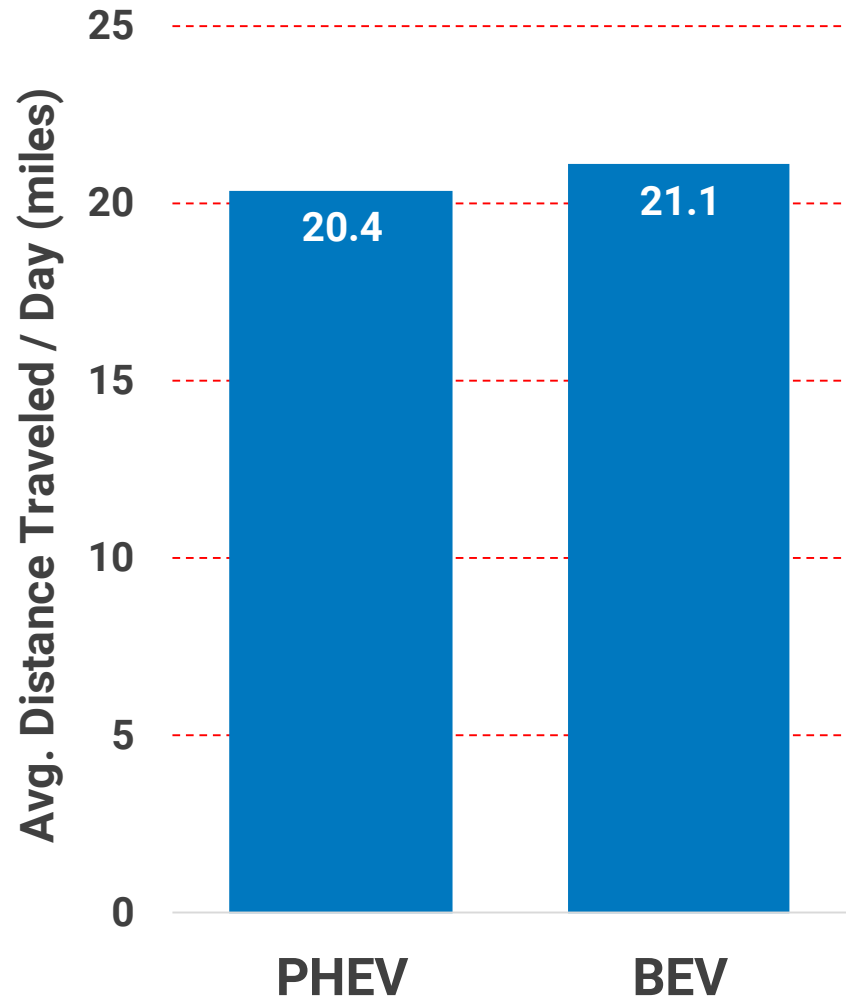
Customer Charging Location Data

Jan 2019 – Dec 2019



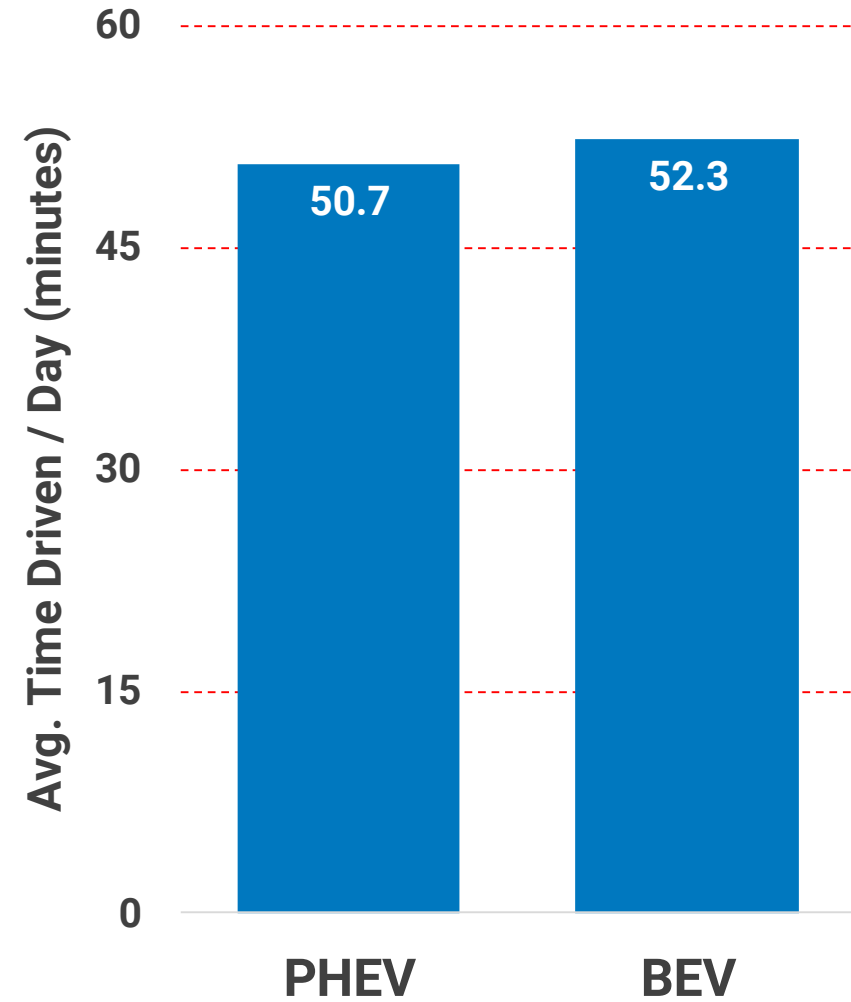
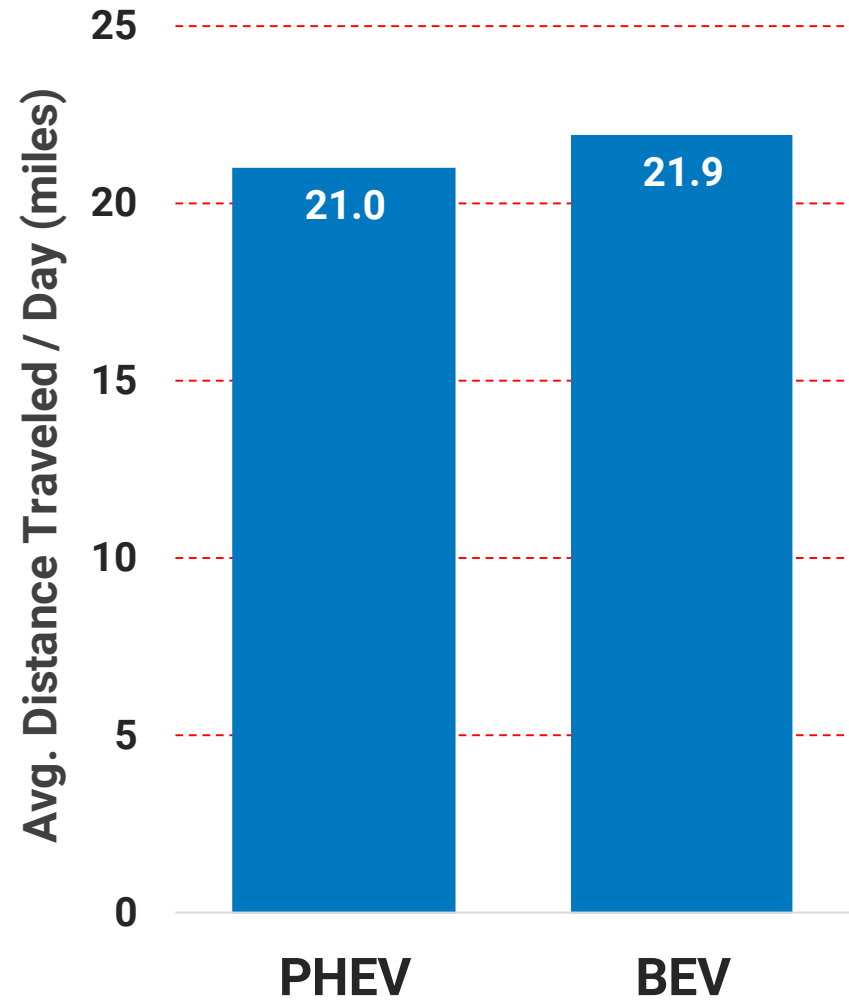
Customer Trip Data

Jan 2019 – Dec 2019



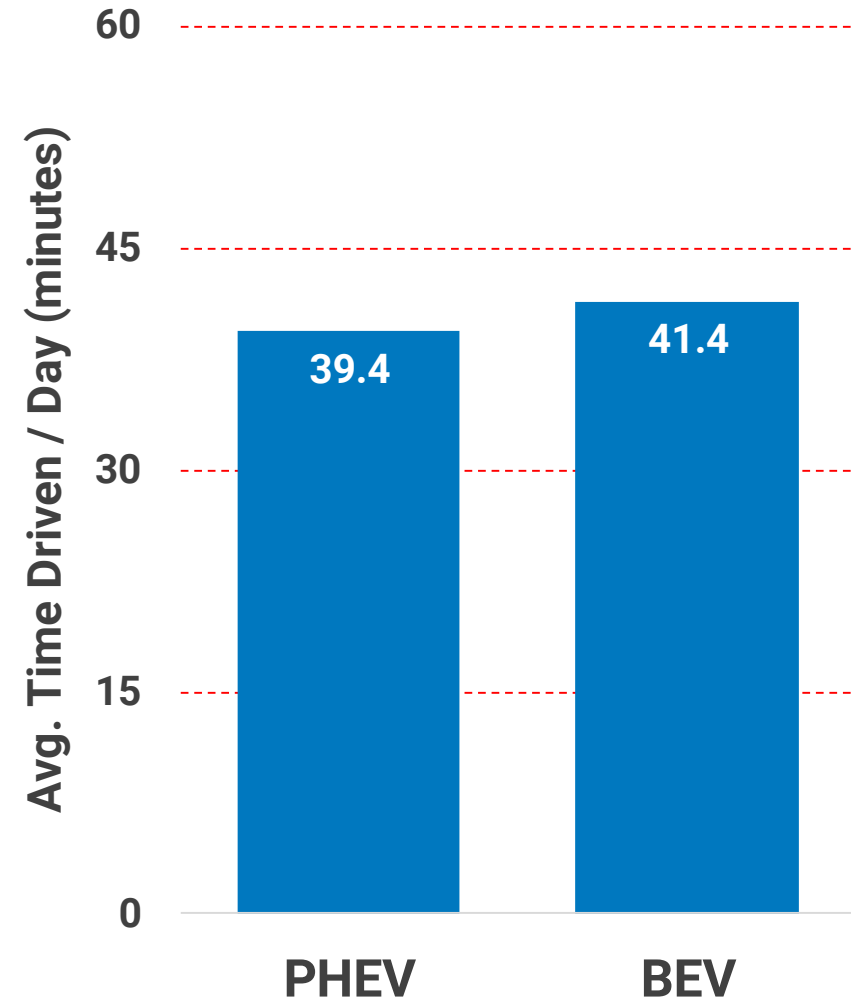
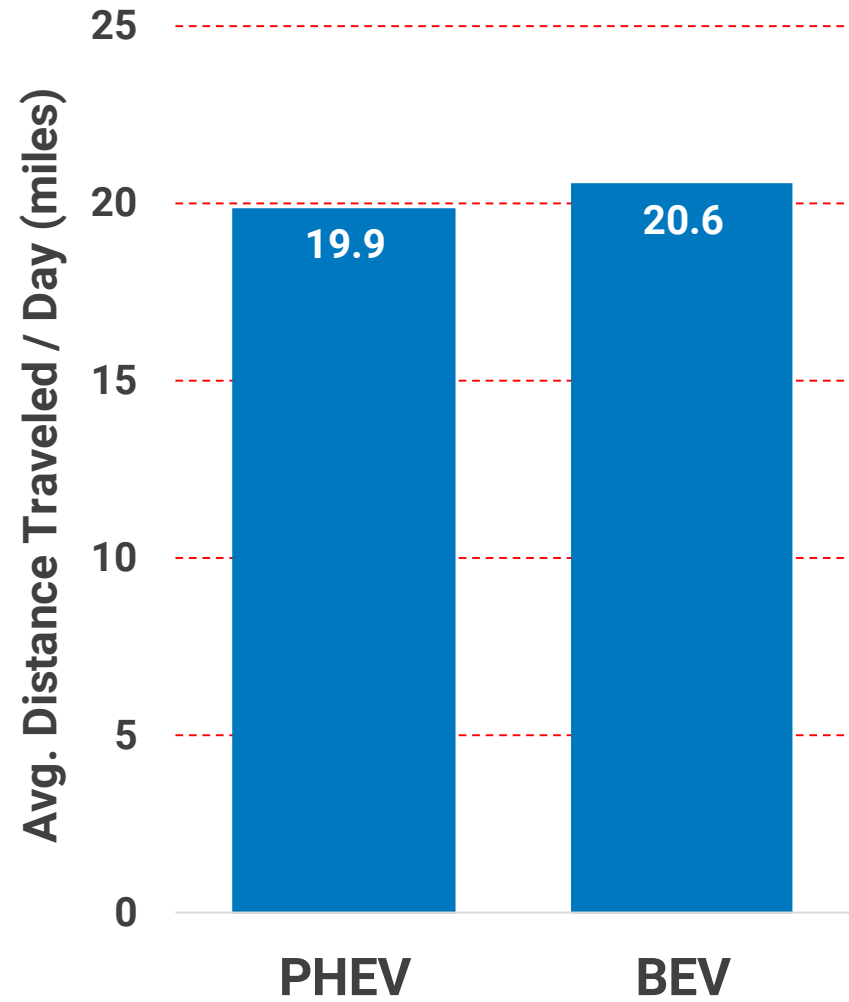
Customer Trip Data

Jan 2019 – Dec 2019, Weekdays



Customer Trip Data

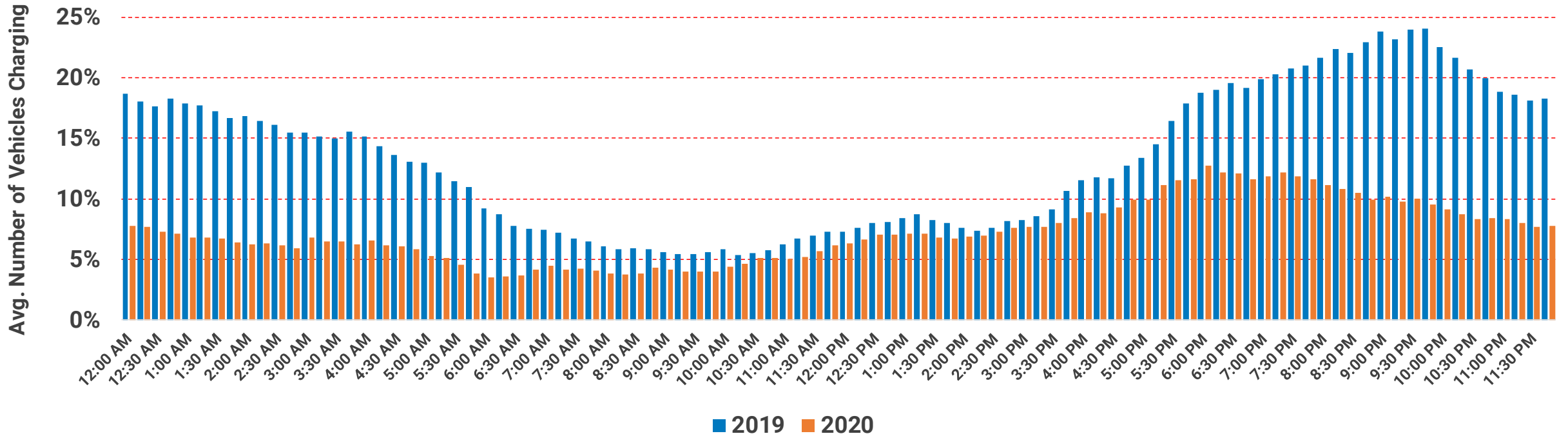
Jan 2019 – Dec 2019, Weekends



2020 Pandemic Impact

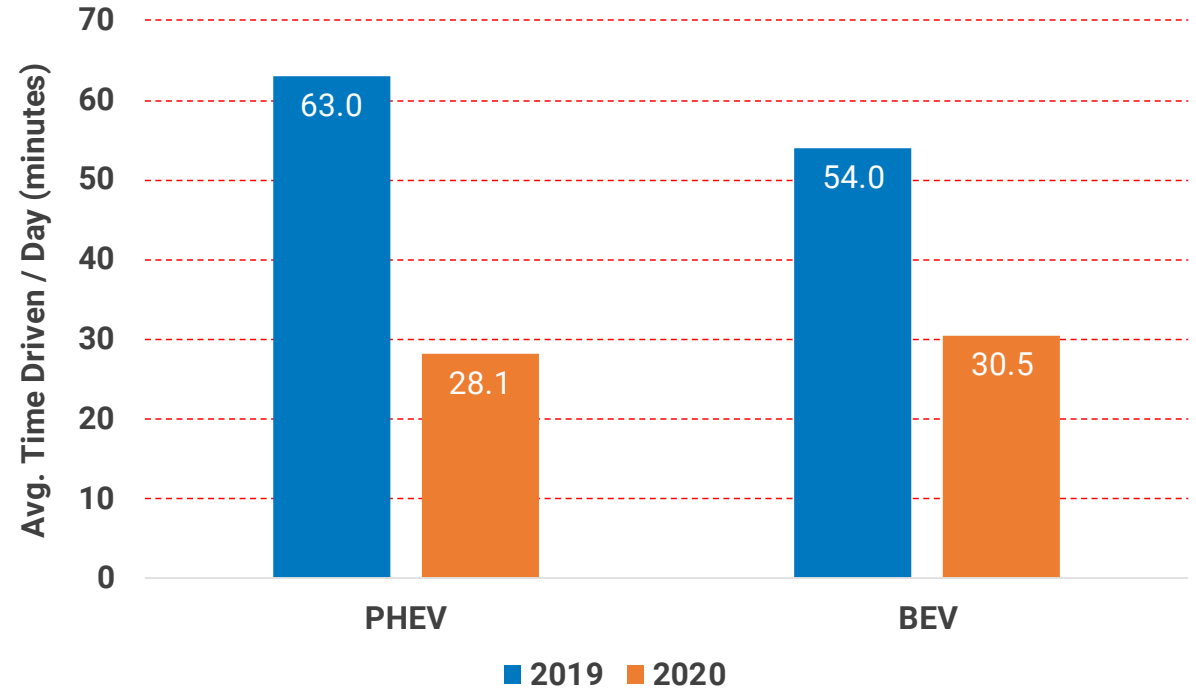
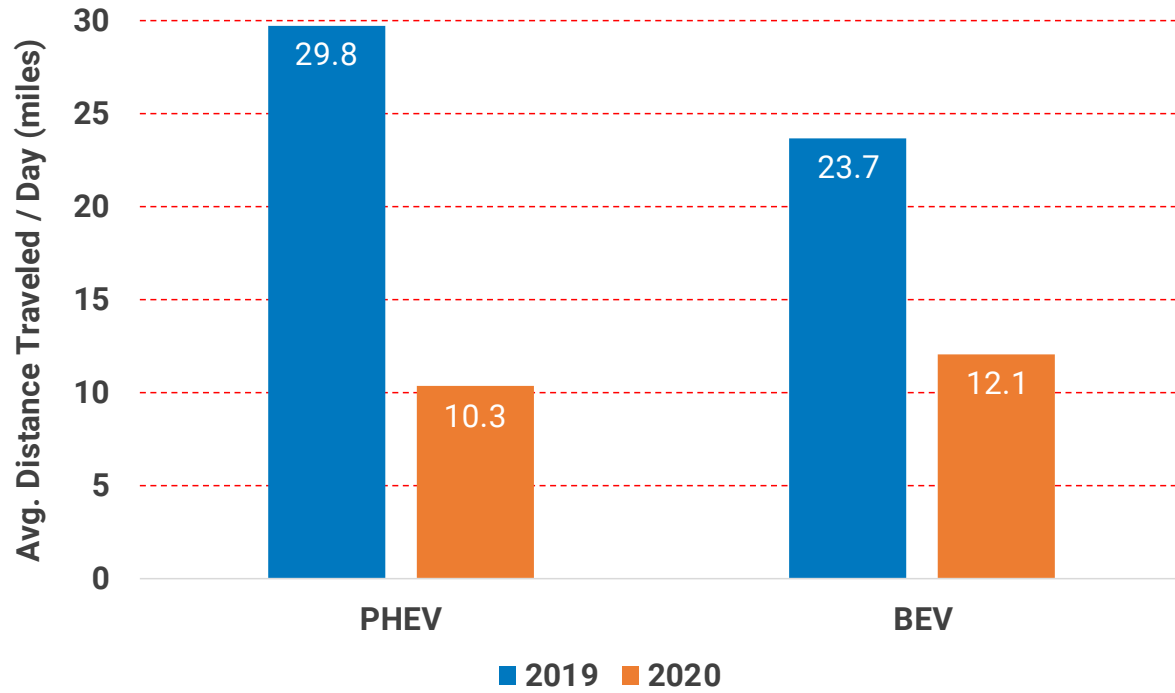
2019 vs. 2020: Customer Charging Data

Apr – May



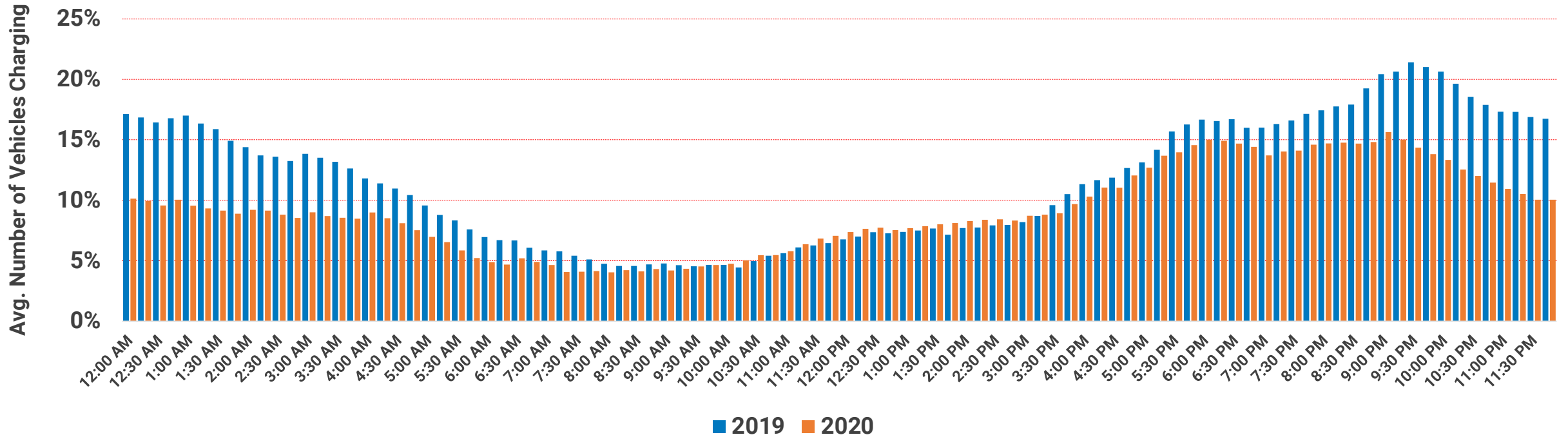
2019 vs. 2020: Customer Trip Data

Apr – May



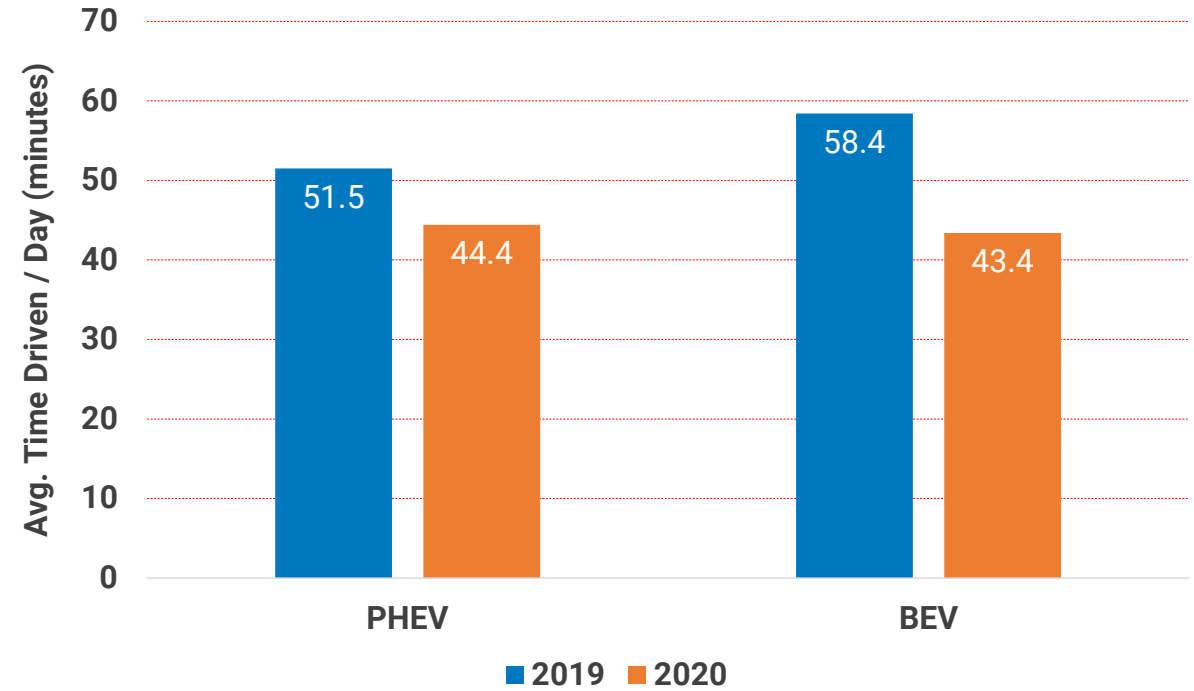
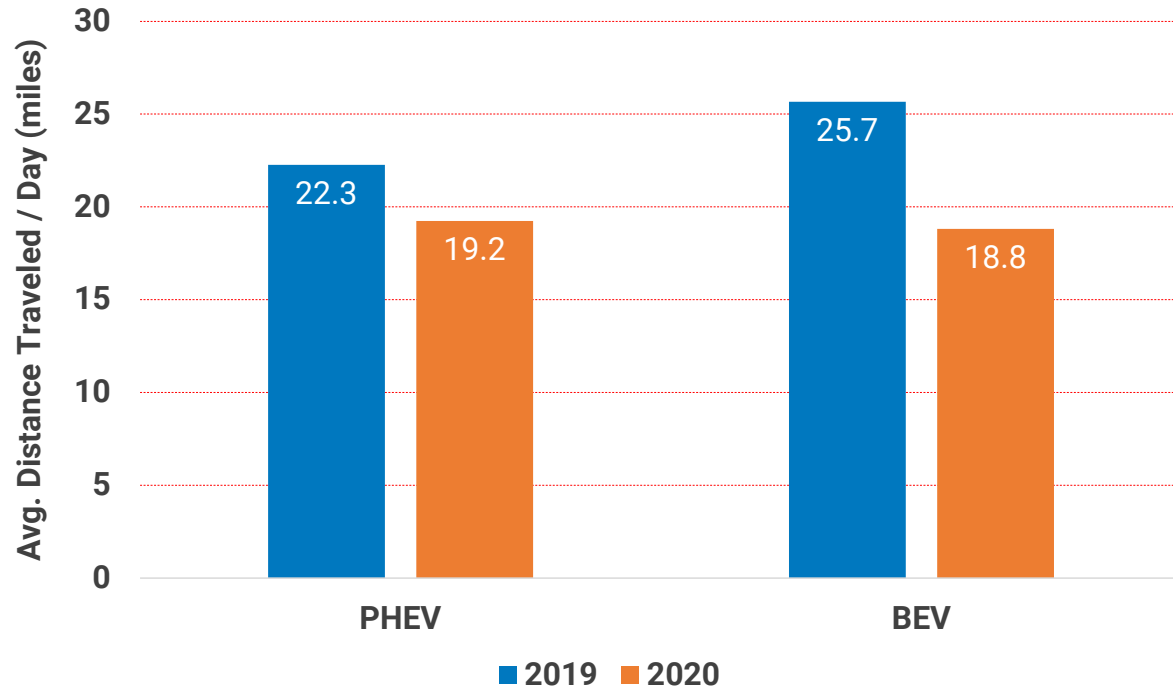
2019 vs. 2020: Customer Charging Data

Jul – Sep



2019 vs. 2020: Customer Trip Data

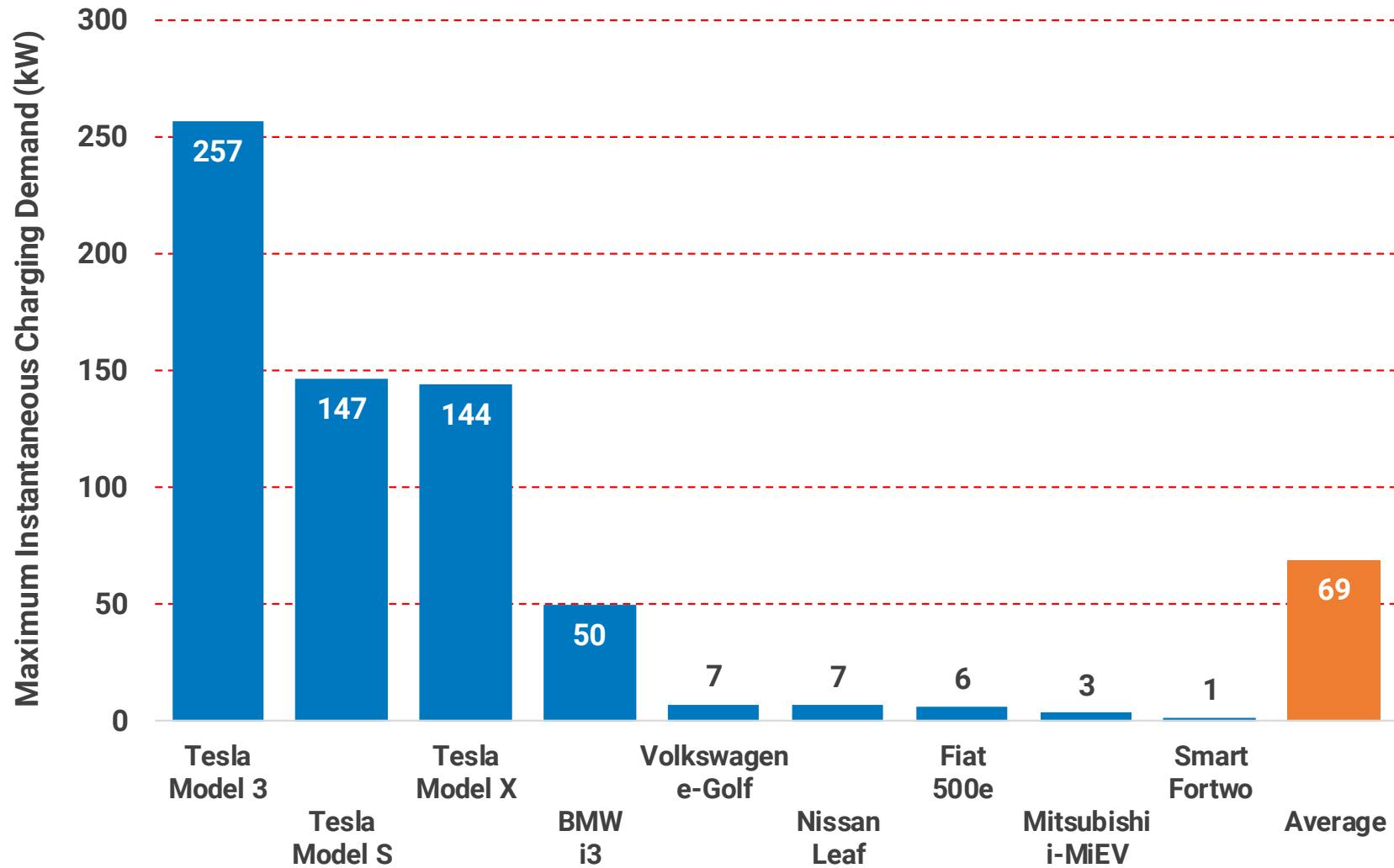
Jul – Sep



2021 Demand Response Pilot

Customer Charging Data

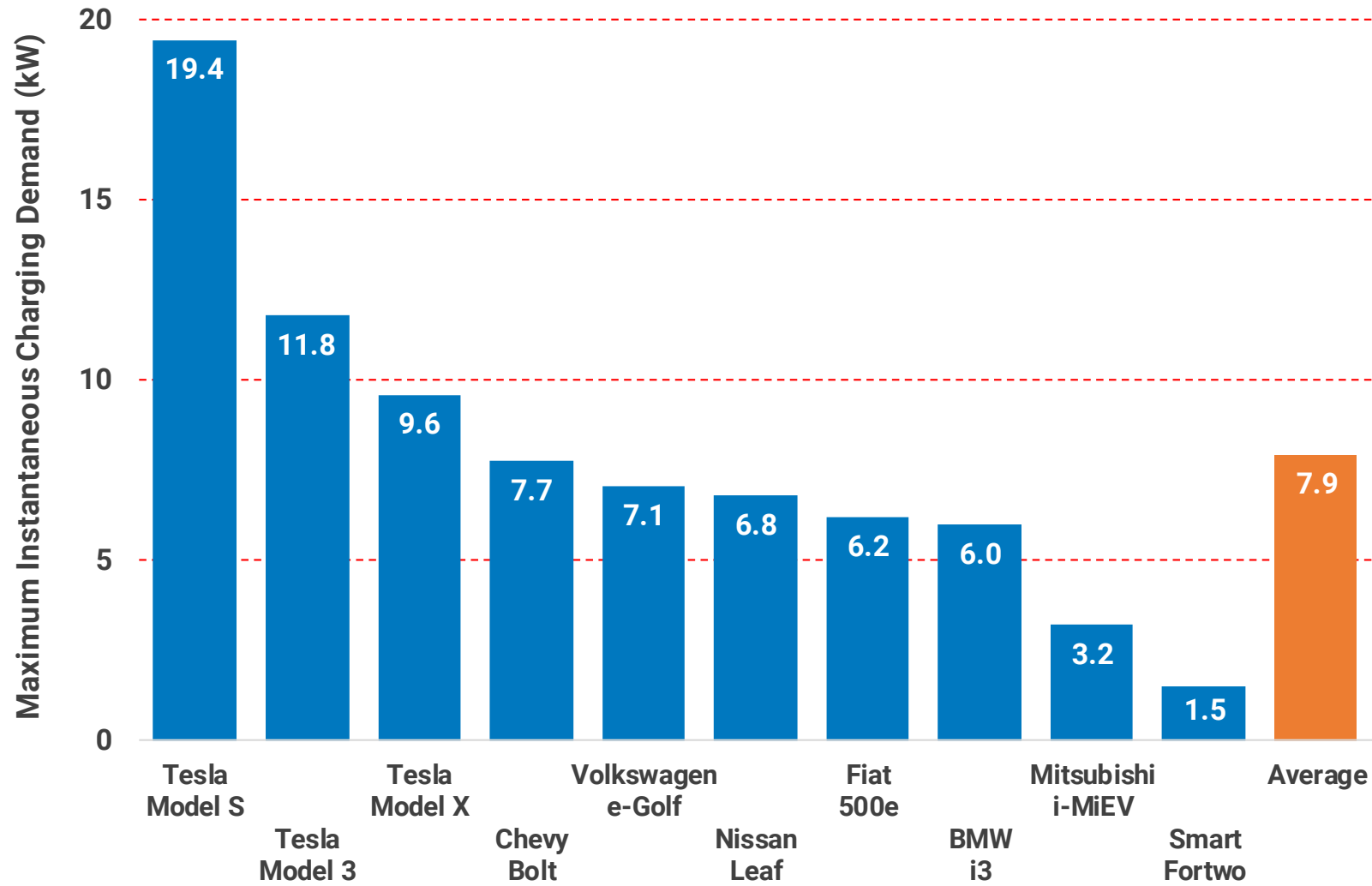
Jan 2019 – Dec 2019, BEV



Note: Chevy Bolt information not included due to irregularities in early 2019 data.

Customer Charging Data

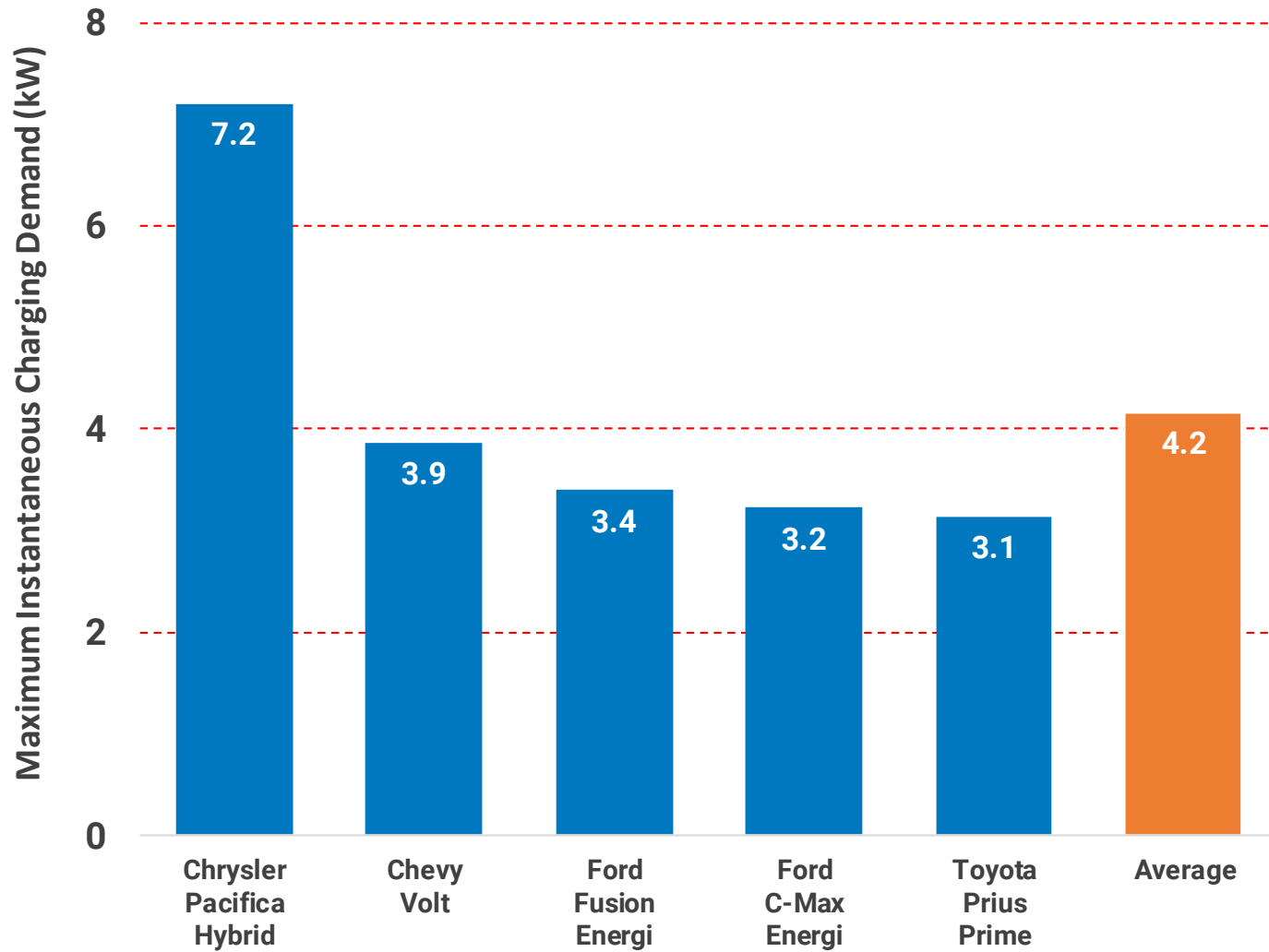
Jan 2019 – Dec 2019, BEV, Home charging only



Average Lincoln air conditioner load ~ 3 kW

Customer Charging Data

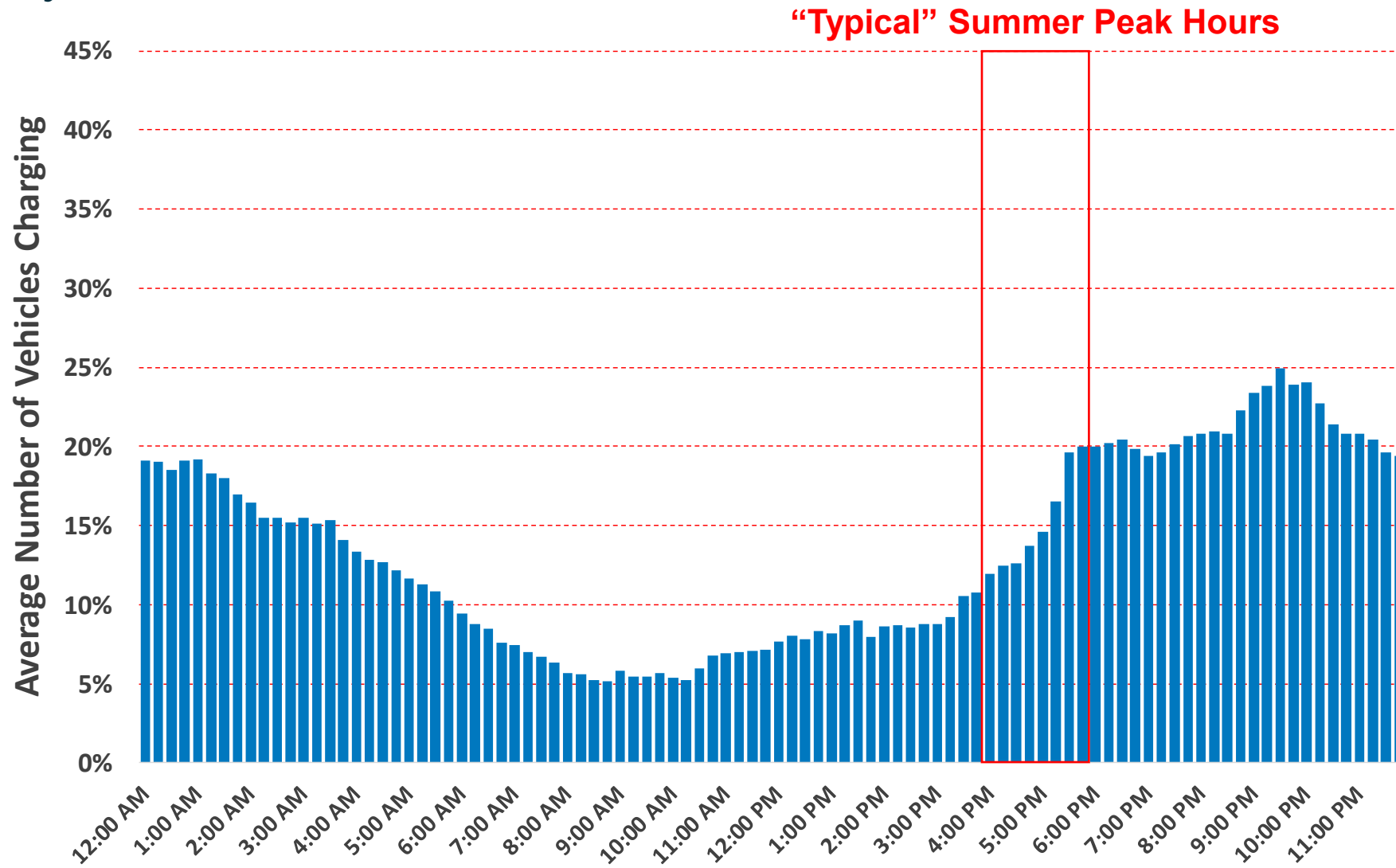
Jan 2019 – Dec 2019, PHEV, Home charging only



Average Lincoln air conditioner load ~ 3 kW

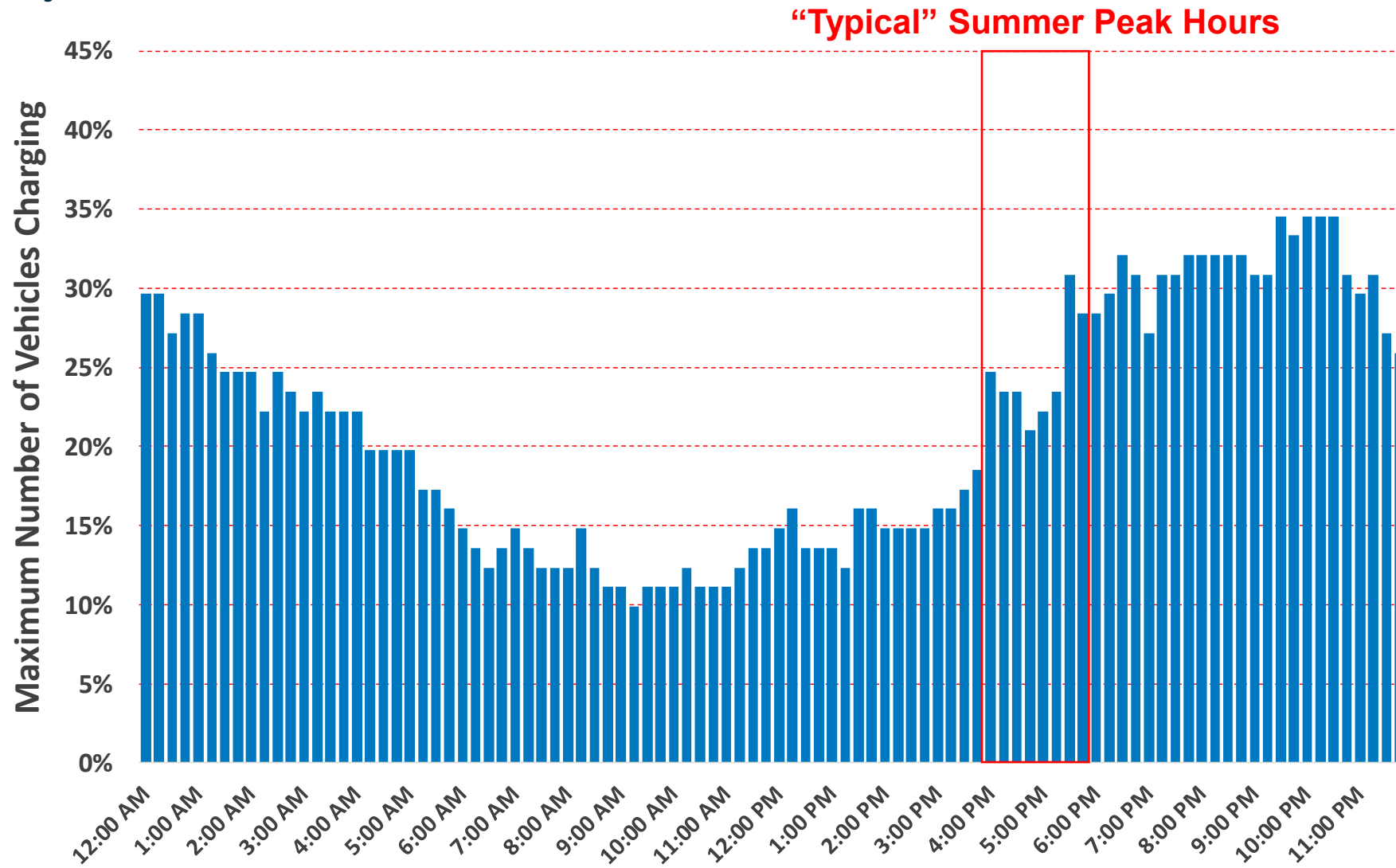
2019 Customer Charging Data

July Weekdays



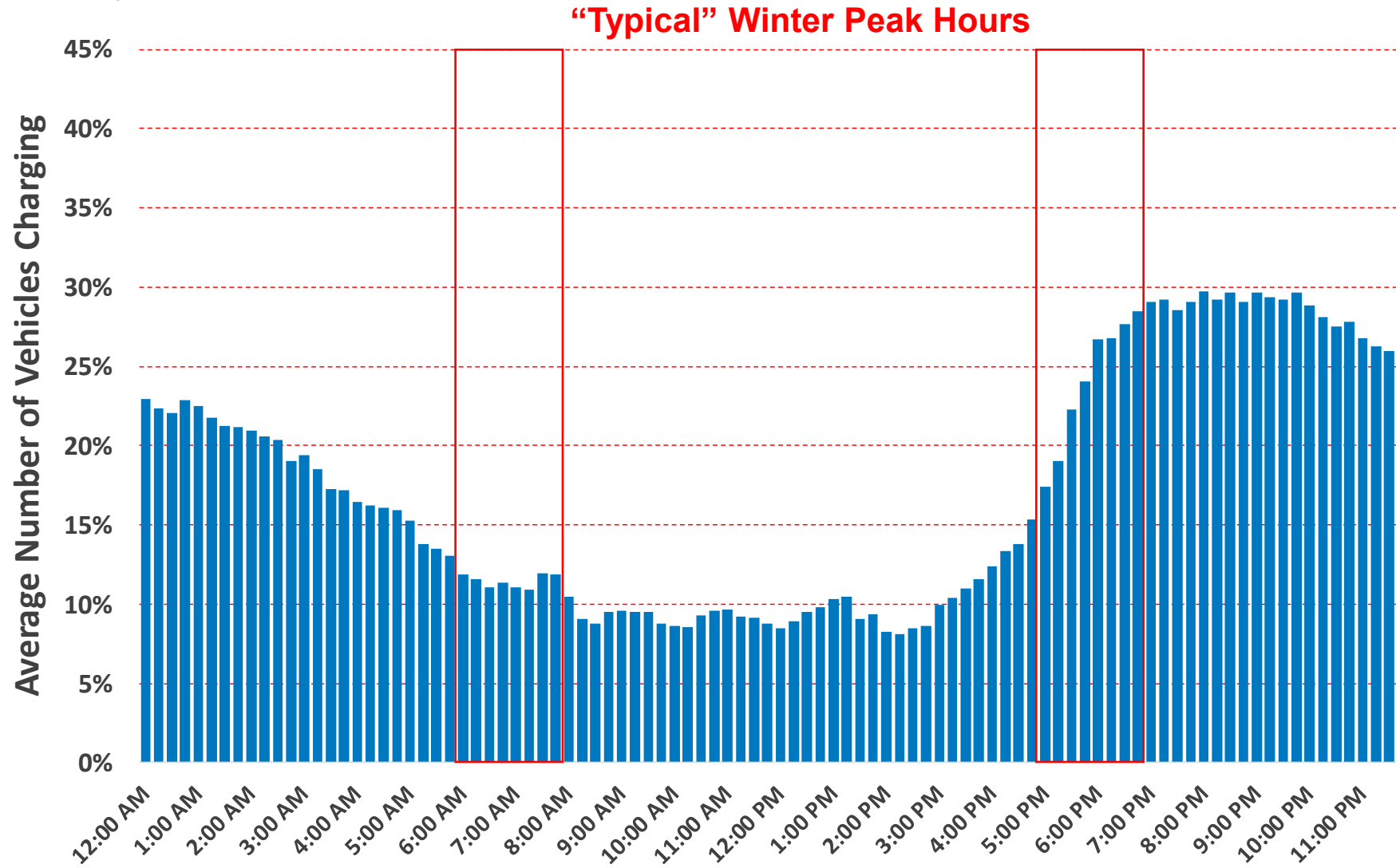
2019 Customer Charging Data

July Weekdays



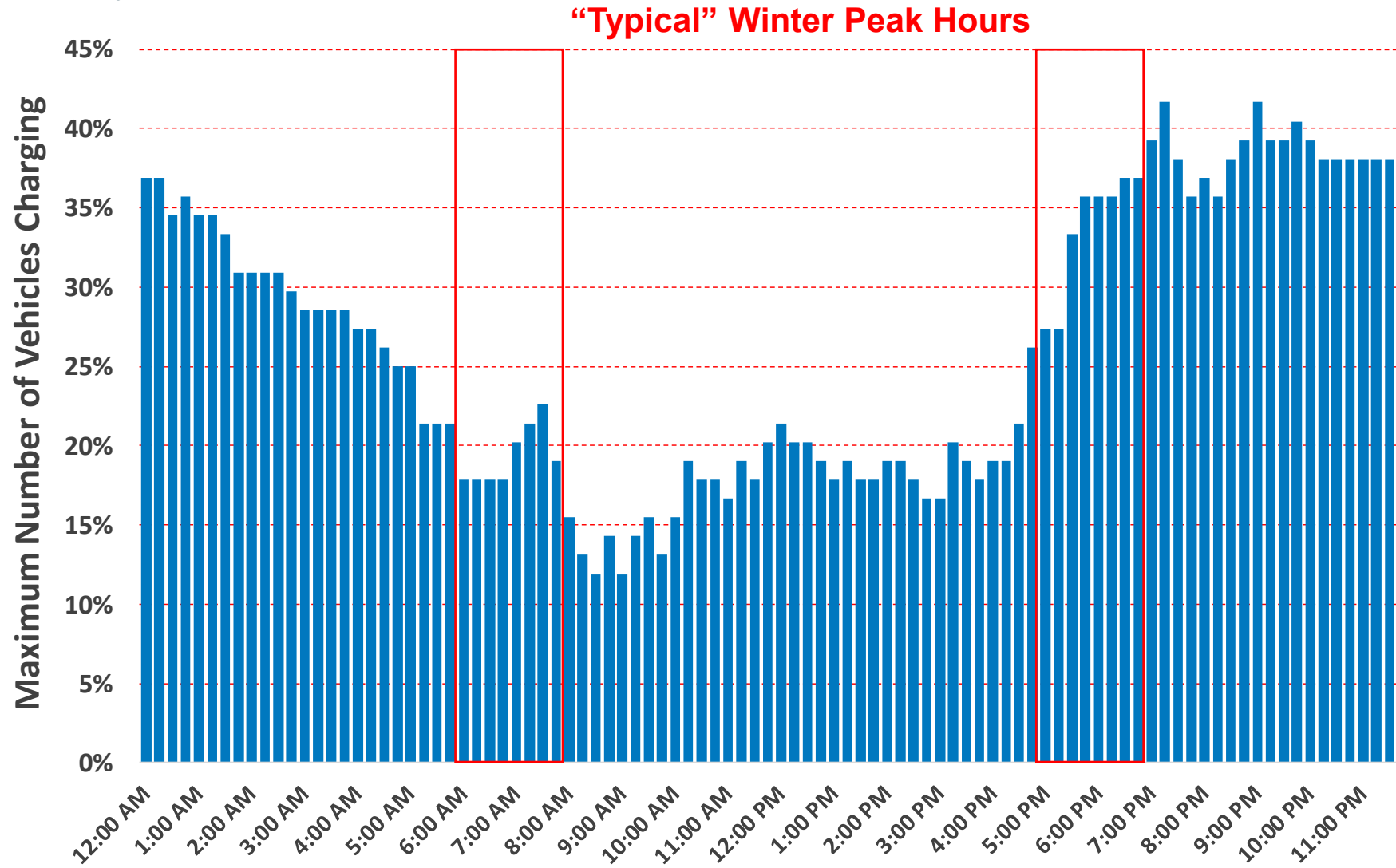
2019 Customer Charging Data

January Weekdays



2019 Customer Charging Data

January Weekdays



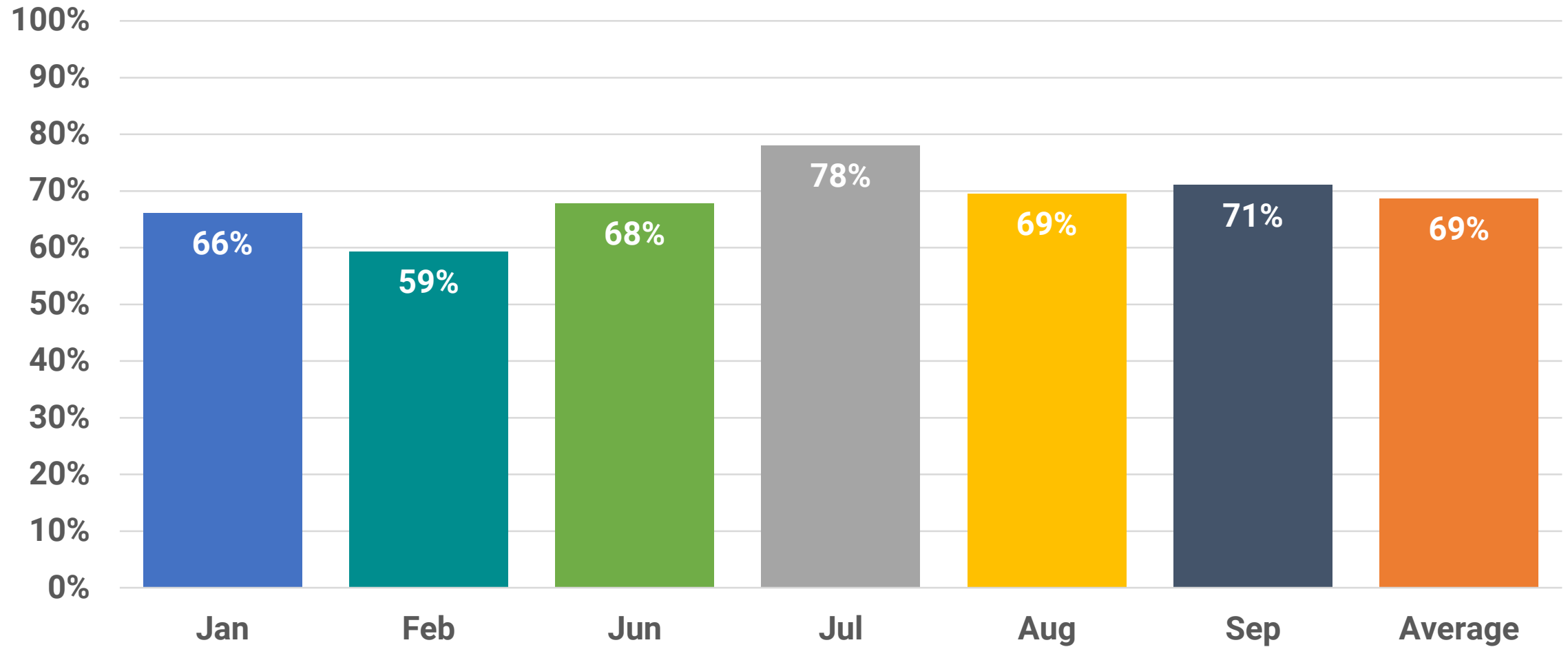
2021 Demand Response Pilot

Months	January – February, June – September
Maximum Events	5/month (30 total)
Customer Notice	Day before event via text/email to customer
Annual Incentive	\$10/month (\$60 total)
Opt-Outs	Allowed, but monthly incentive only awarded if customer complies with all DR events/month.
Enrollees	66
Participating Vehicles	61

- Chevrolet Bolt
- Chevrolet Volt
- Chrysler Pacifica PHEV
- Ford C-Max Energi
- Ford Fusion Energi
- Kia Soul EV
- Mitsubishi i-MiEV
- Nissan Leaf
- Smart Fortwo ED
- Tesla Model 3
- Tesla Model S
- Tesla Model X
- Toyota Prius Prime

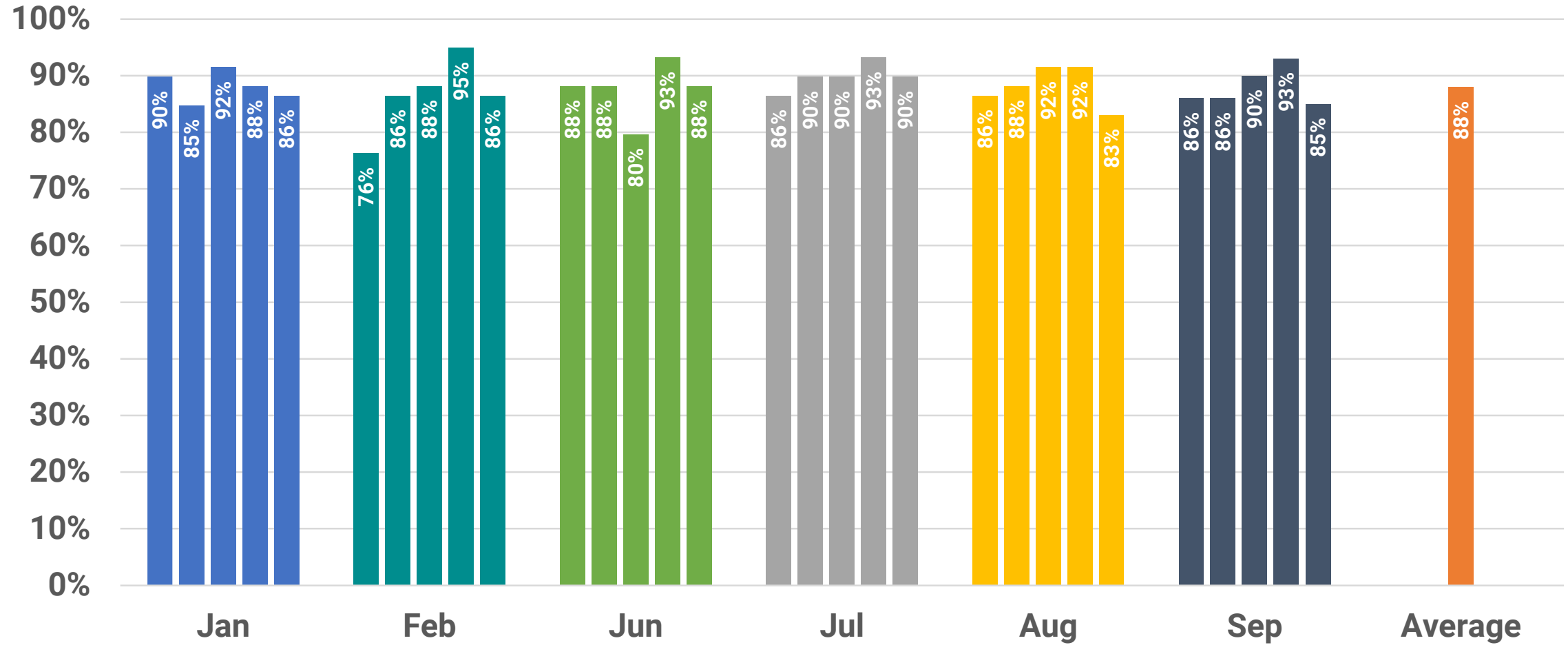
Demand Response Event Curtailment Rates

Compliance with all 5 events/month



Demand Response Event Curtailment Rates

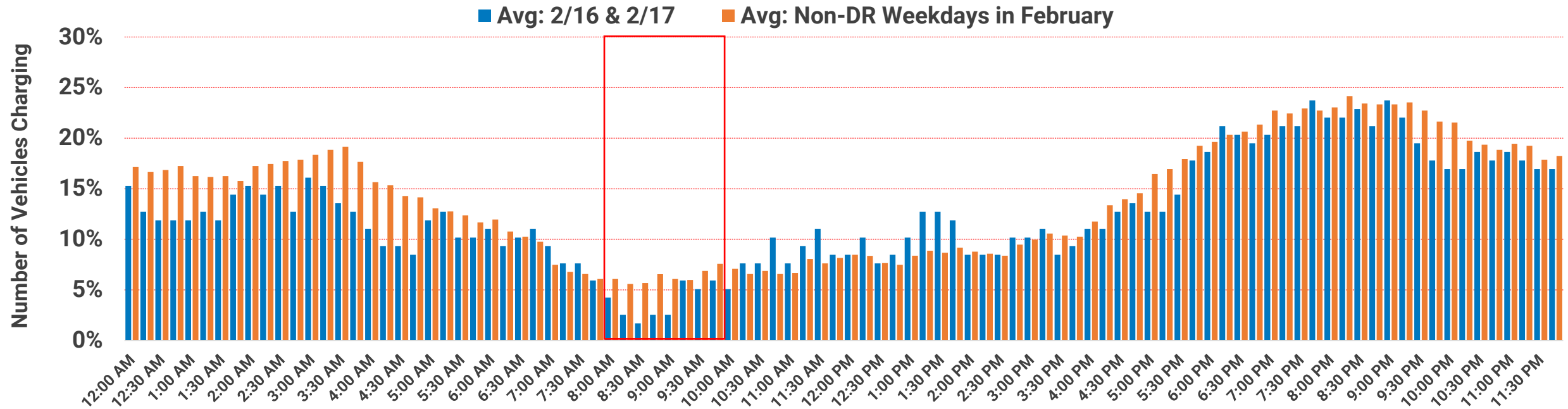
Compliance/event



Winter Morning Events

8:00 am – 10:00 am: Tue 2/16/21 & Wed 2/17/21

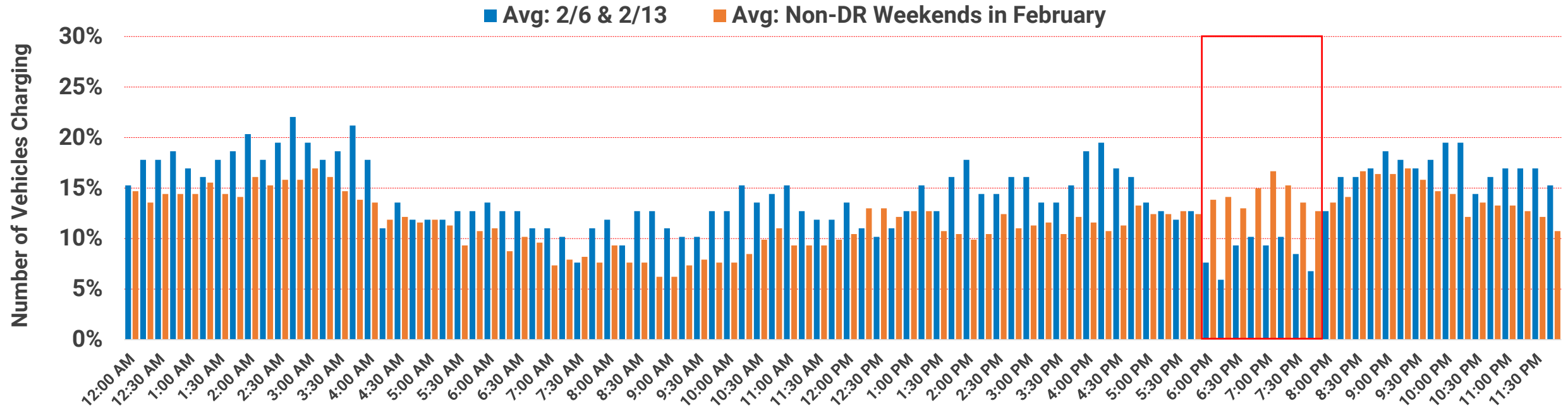
Morning events not as impactful due to typically lower charging levels.



Winter Evening Events

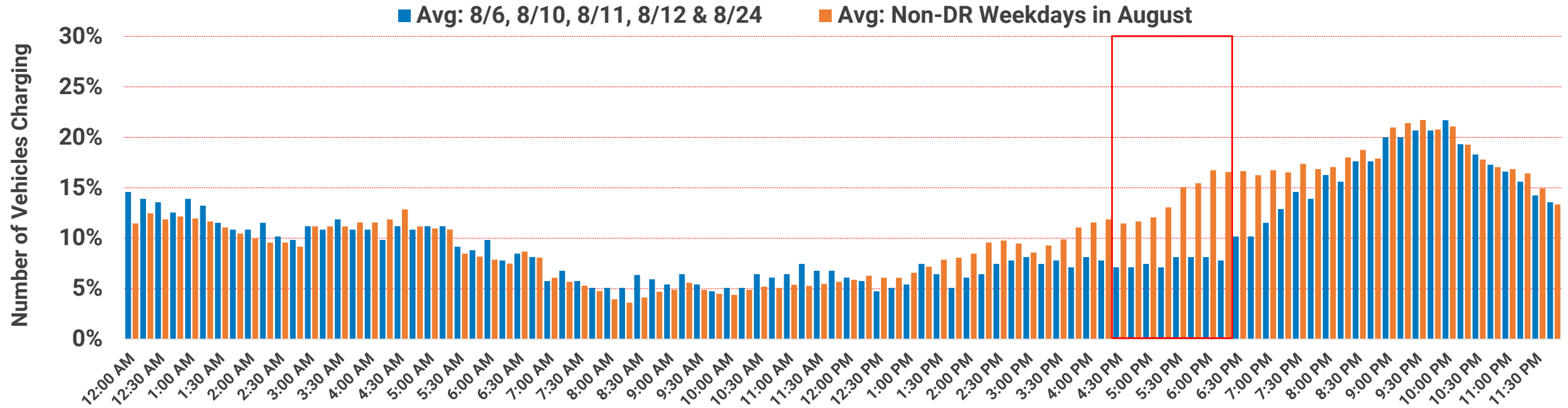
6:00 pm – 8:00 pm: Sat 2/6/21 & Sat 2/13/21

Evening events more impactful due to typically higher charging levels.



Summer Evening Events

4:30 pm – 6:30 pm: *Fri 8/6/21, Tue 8/10/21, Wed 8/11/21, Thu 8/12/21 & Tue 8/24/21*



Thank you!



Electric vehicle study made possible in part through grant funding from:



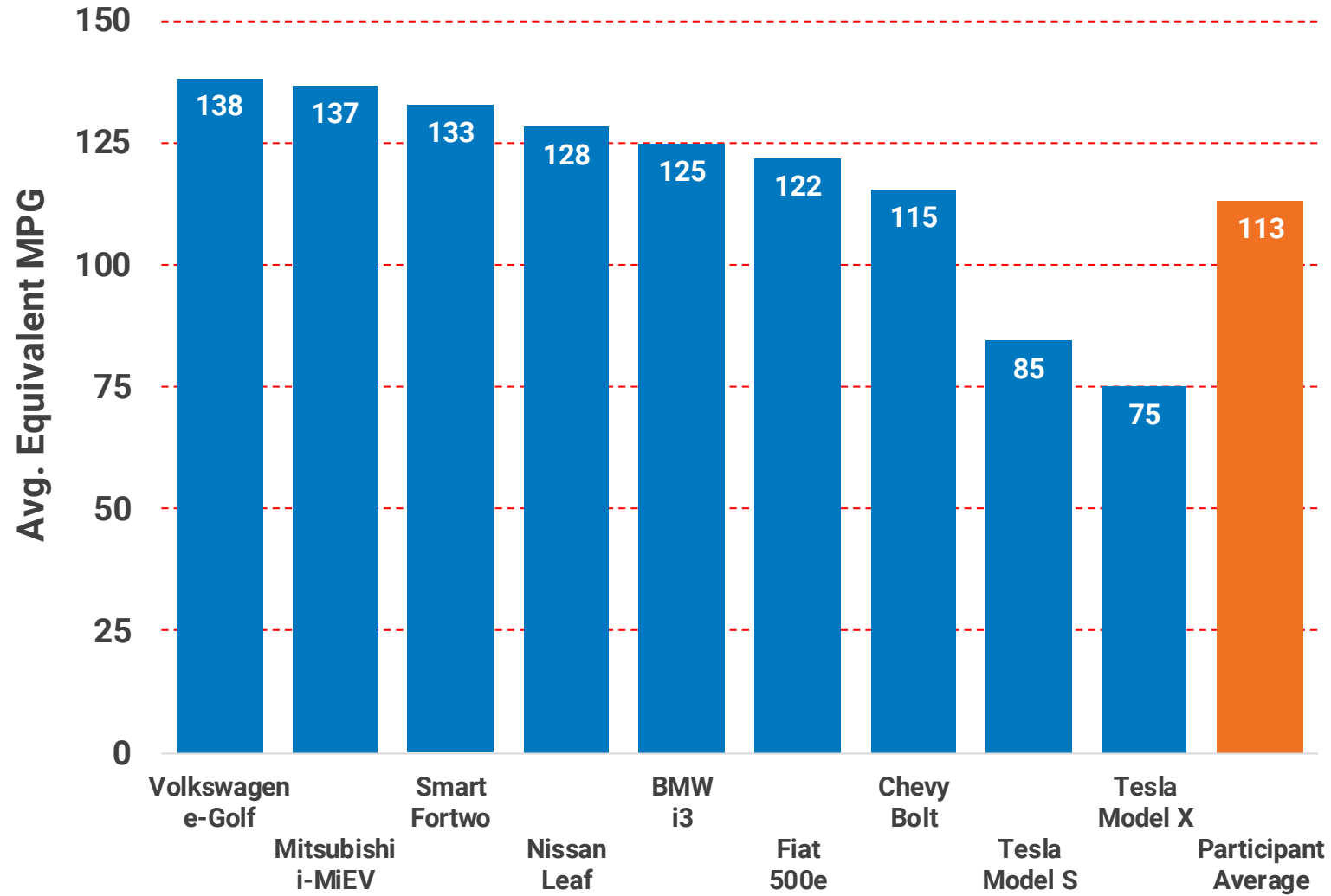
Project FAQ

Frequently Asked Questions

Q: On average, how much better are the equivalent miles-per gallon for a BEV as compared to a PHEV?

Customer Trip Data

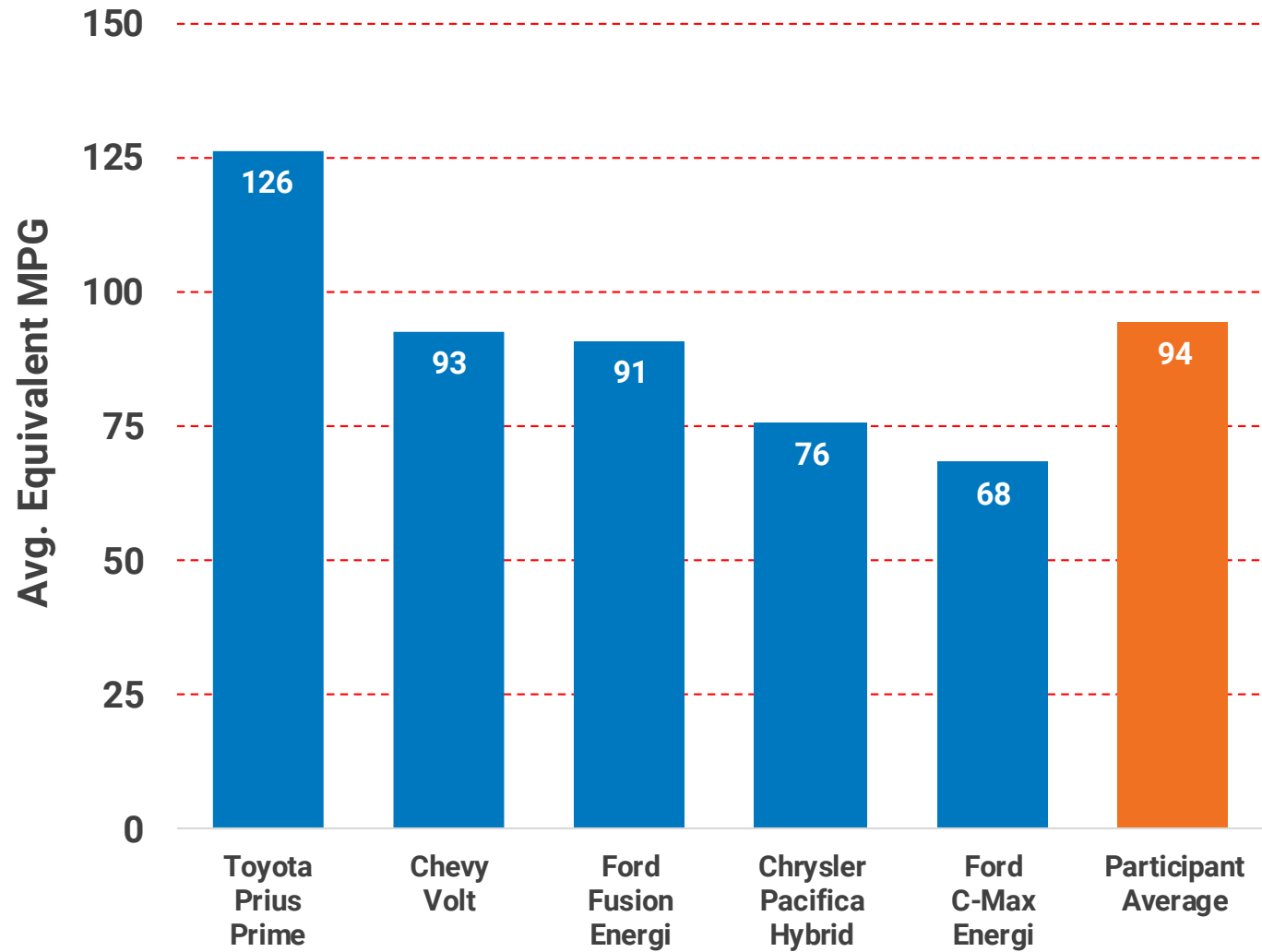
Jan 2019 – Dec 2019, BEV



Note: Tesla Model 3 information not included due to irregularities in early 2019 data.

Customer Trip Data

Jan 2019 – Dec 2019, PHEV



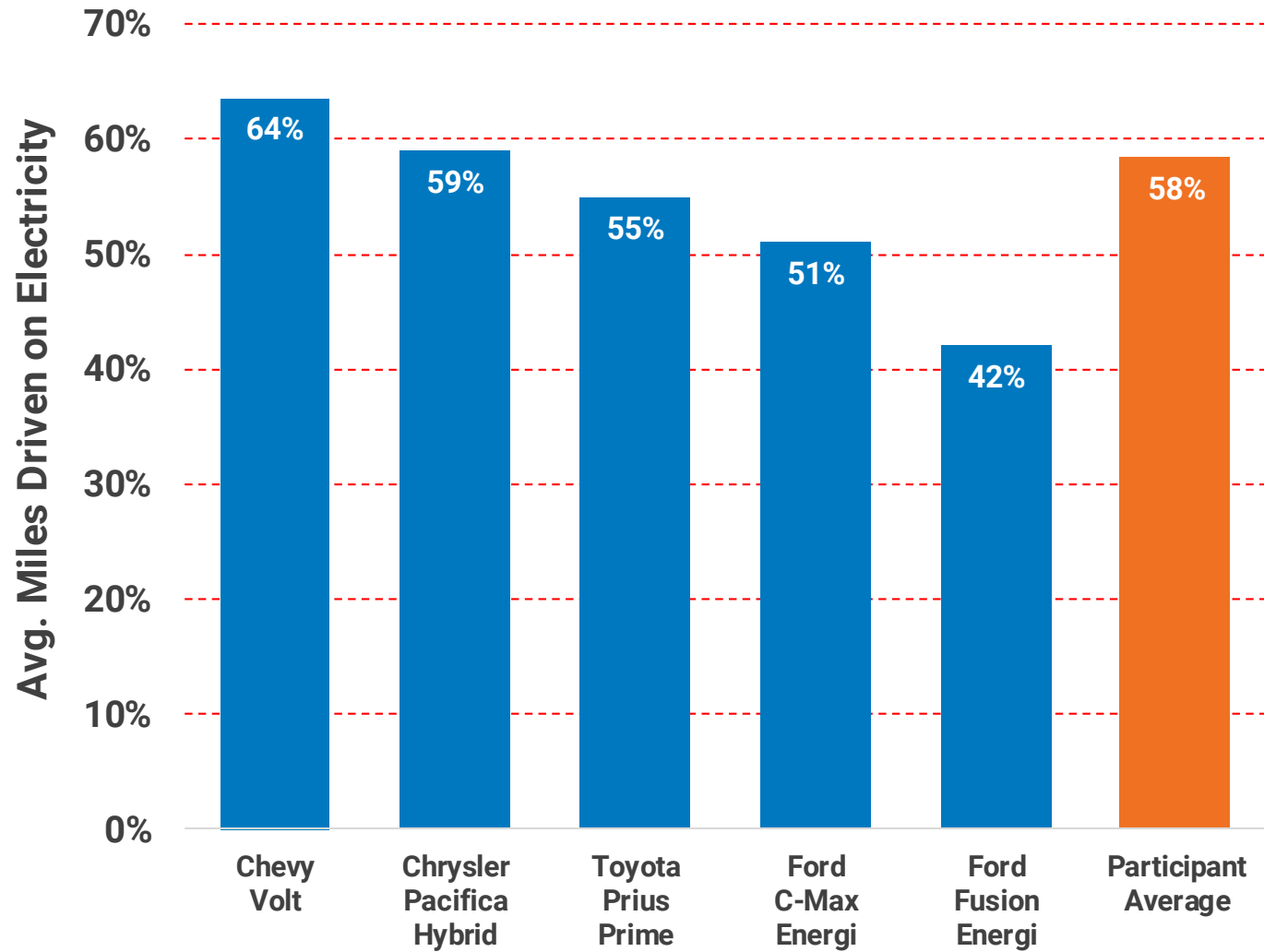
On average, BEV MPGe are ~ 1.25 times that of PHEV.

Frequently Asked Questions

Q: On average, how much of the plug-in hybrid vehicle's mileage is powered by electricity?

Customer Trip Data

Jan 2019 – Dec 2019, PHEV

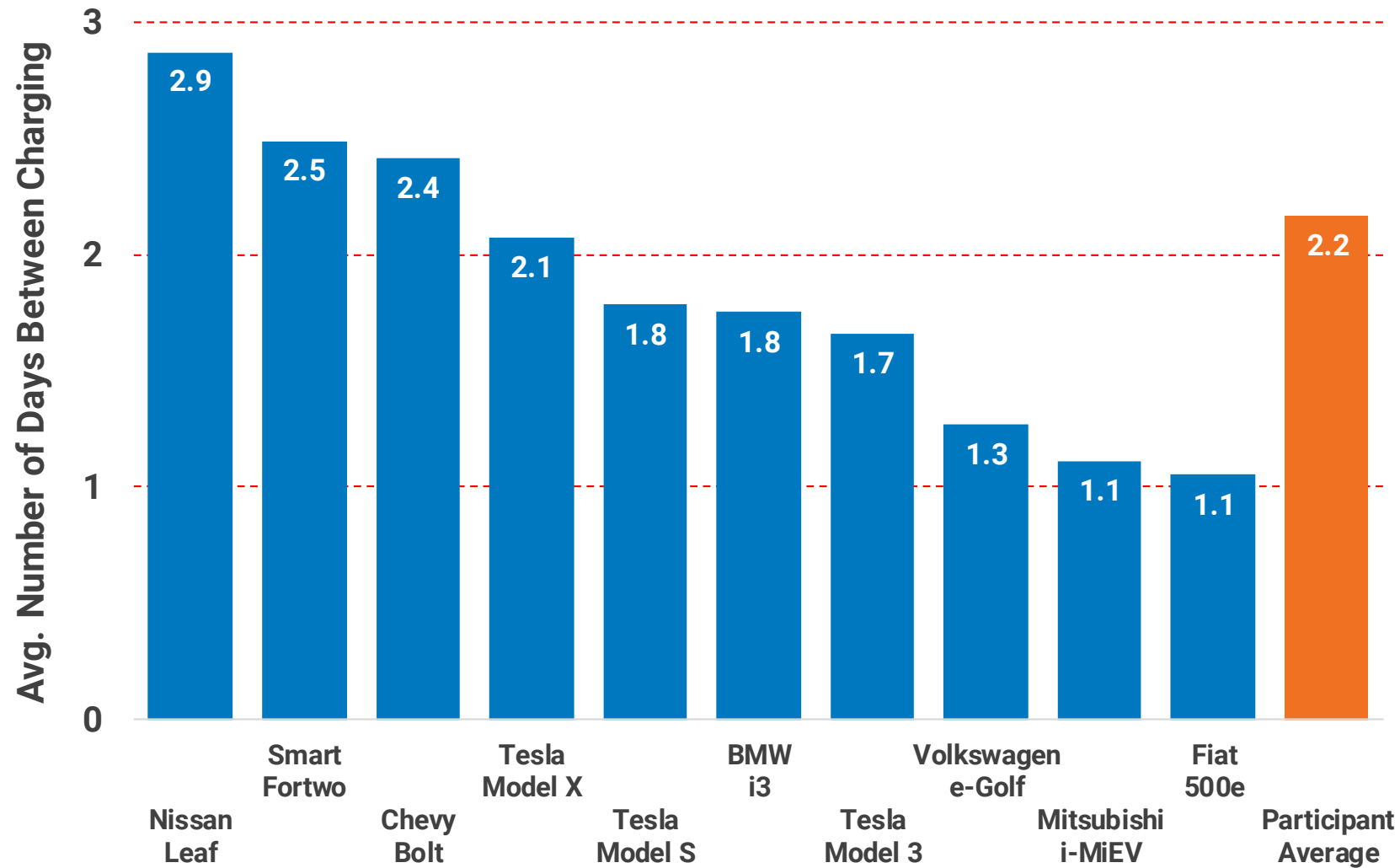


Frequently Asked Questions

Q: On average, how many days do people go between charging sessions?

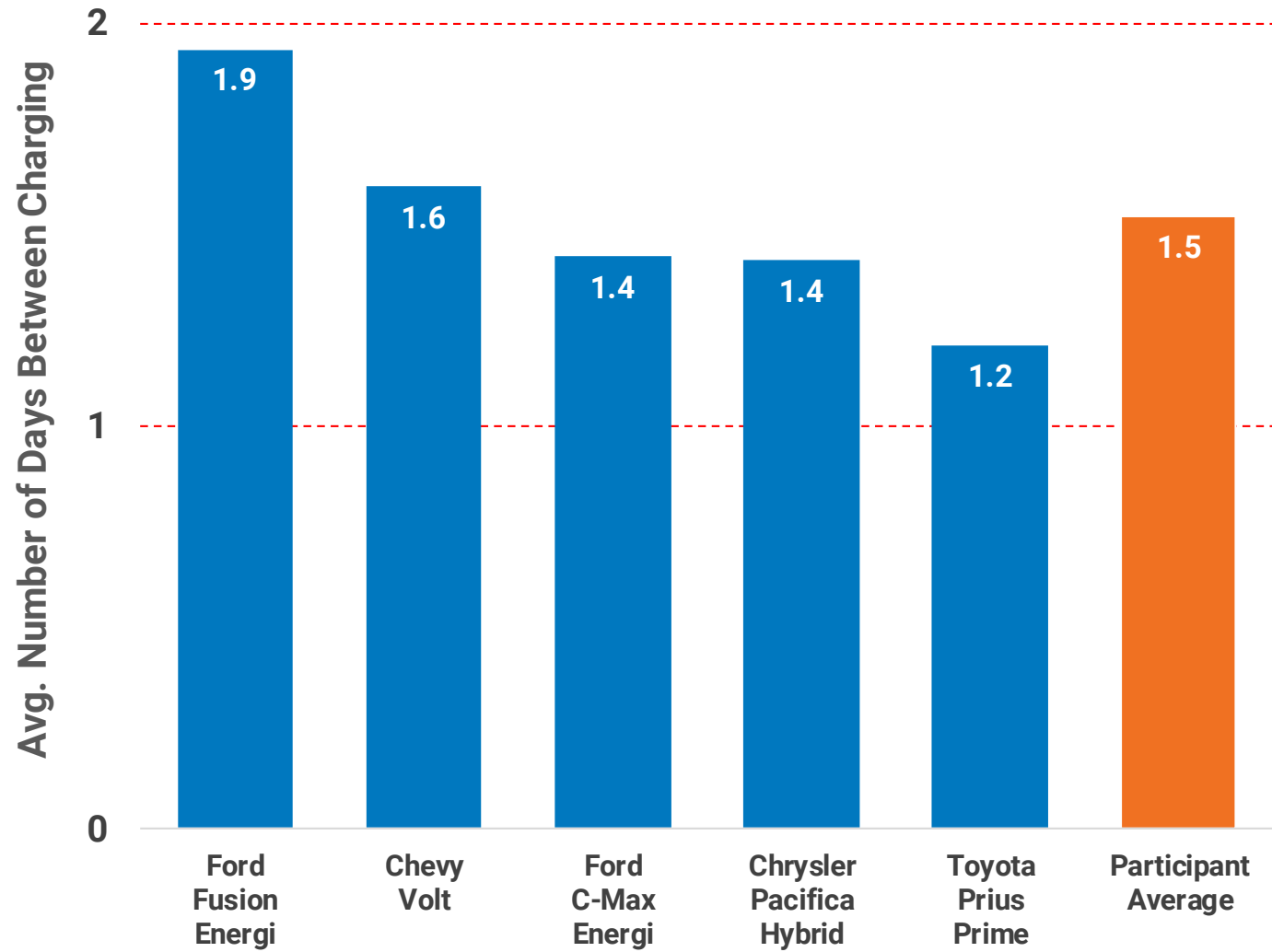
Customer Charging Data

Jan 2019 – Dec 2019, BEV



Customer Charging Data

Jan 2019 – Dec 2019, PHEV



Frequently Asked Questions

Q: What month saw the highest charging energy consumption, in terms of average daily charging energy consumption per vehicle?

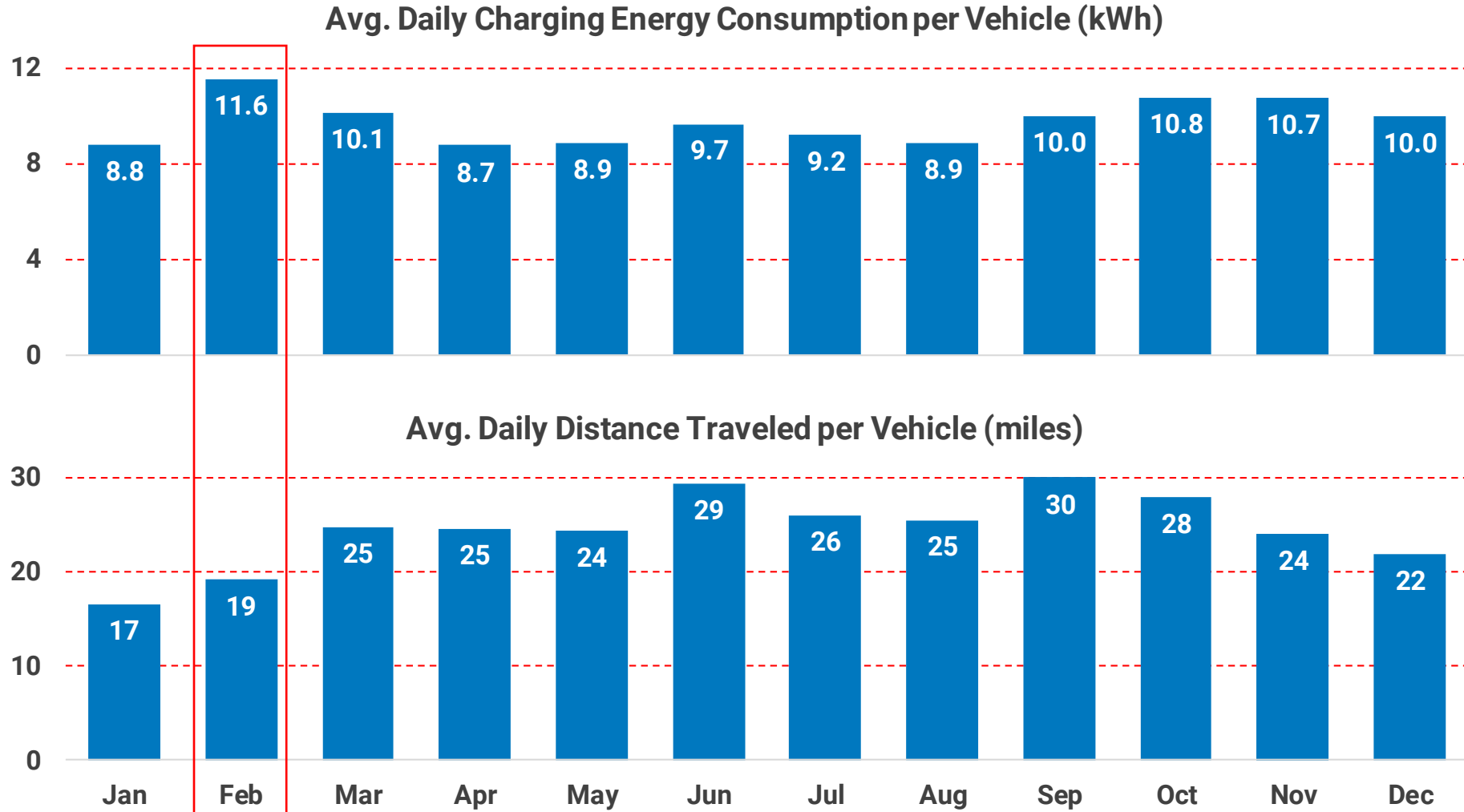
Q: What month saw the lowest charging energy consumption?

Q: What month saw the most vehicle usage, in terms of average daily distance traveled per vehicle?

Q: What month saw the lowest vehicle usage?

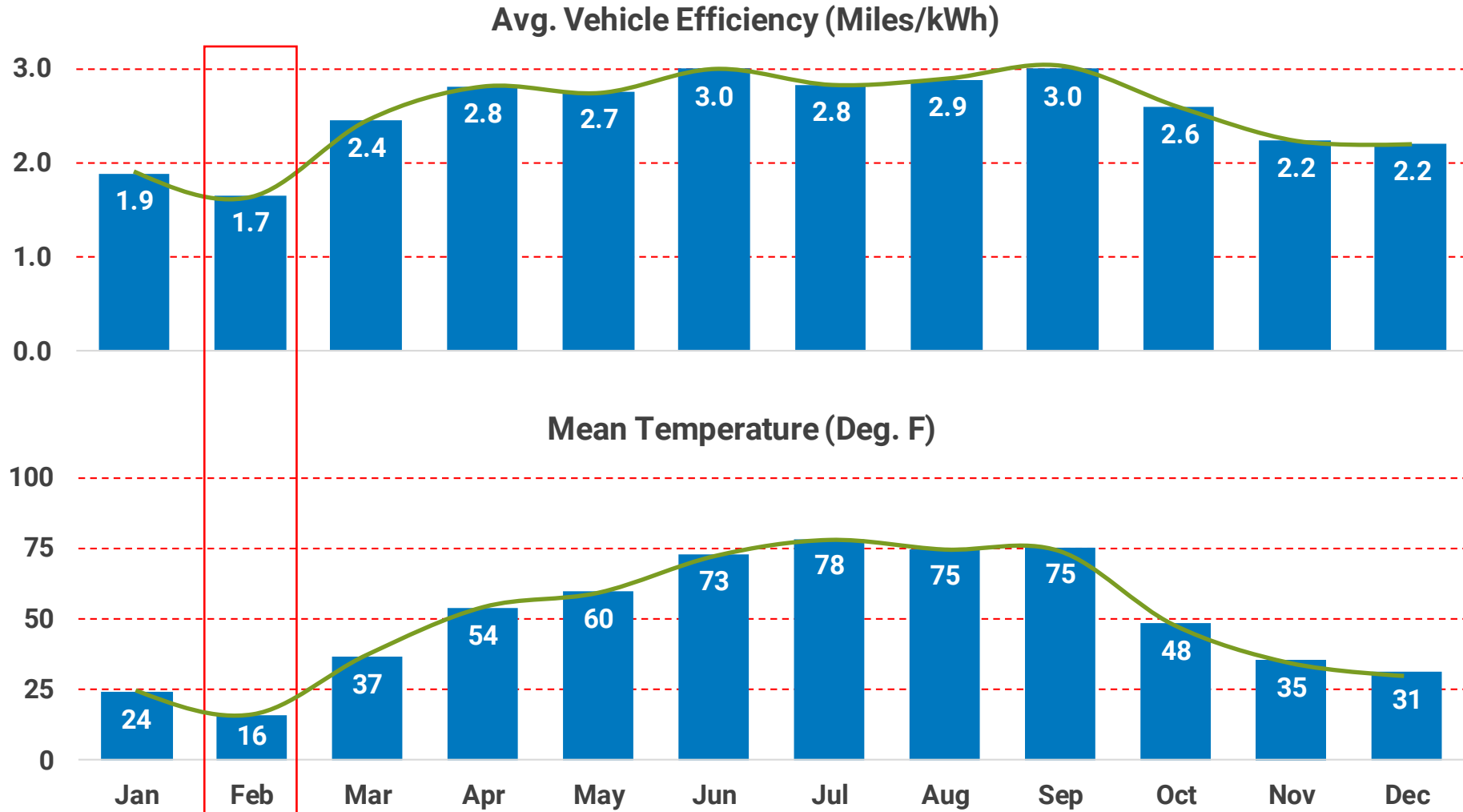
Seasonal Variations

2019, BEV, Weekdays



Seasonal Variations

2019, BEV, Weekdays



Frequently Asked Questions

Q: Per the previous slide, BEV efficiency ranged from a monthly average of 1.7 to 3.0 miles/kWh. What efficiency did LES' first BEV average for 1980 - 1981?



Frequently Asked Questions

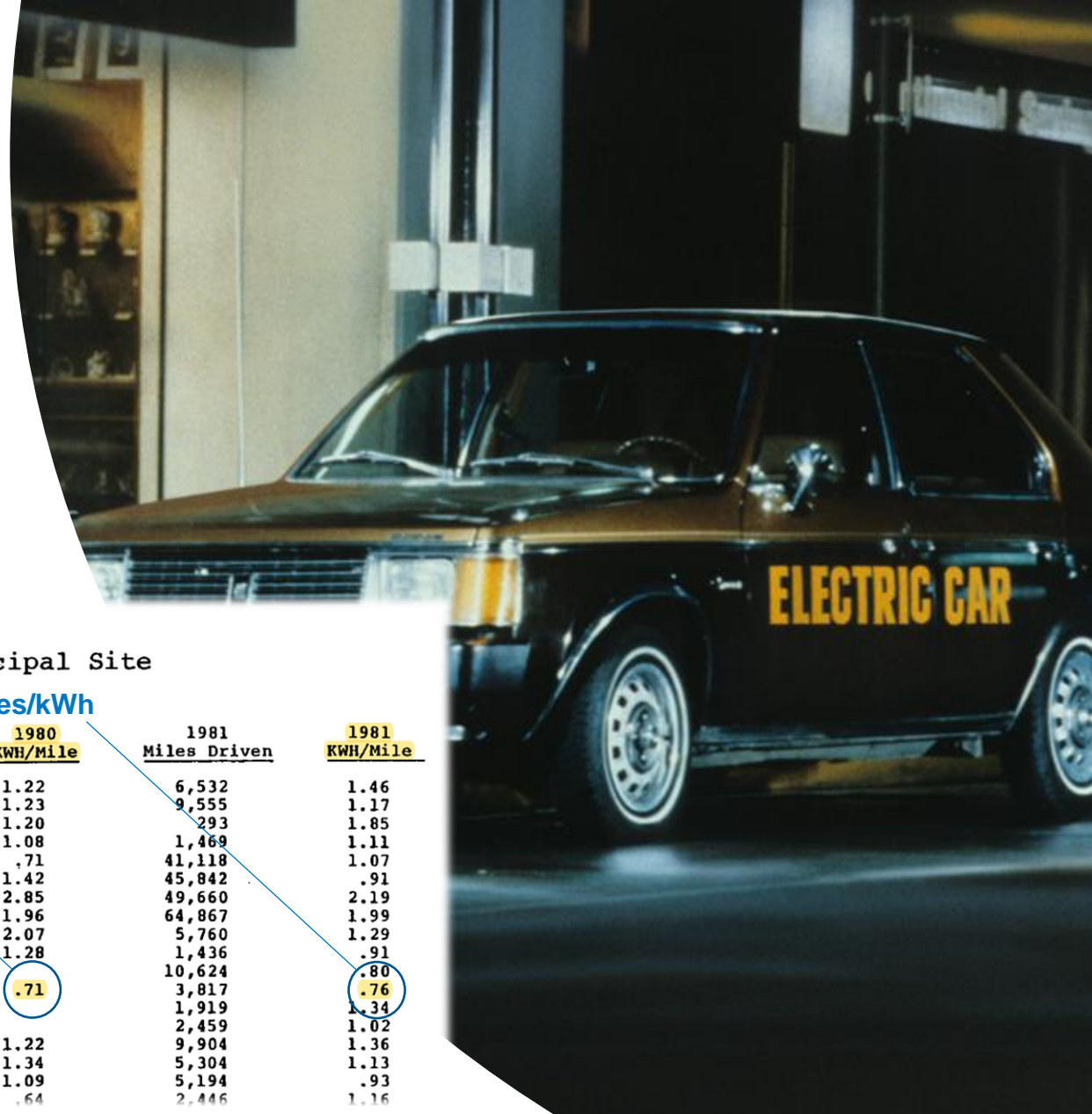
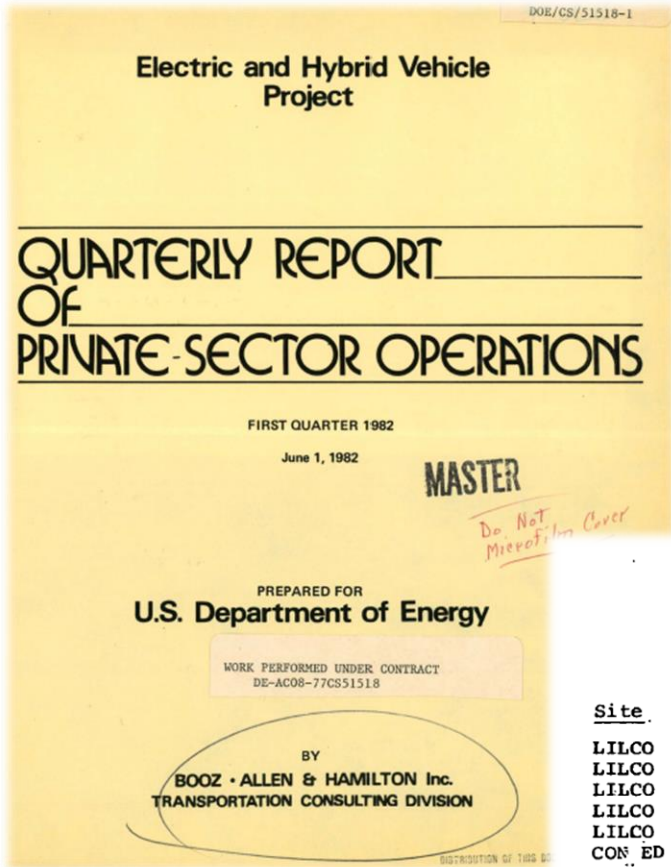


TABLE 9
Energy Usage by Principal Site

1.4 miles/kWh

1.3 miles/kWh

Site	Vehicle Type	1980	1980	1981	1981
		Miles Driven	KWH/Mile	Miles Driven	KWH/Mile
LILCO	EVA Pacer Wagon	6,052	1.22	6,532	1.46
LILCO	Jet Ind. 600 Van	15,428	1.23	9,555	1.17
LILCO	Jet Ind. 1000 Van	837	1.20	293	1.85
LILCO	Jet Ind. 750 Truck	157	1.08	1,469	1.11
LILCO	Jet Ind. Electrica	3,105	.71	41,118	1.07
CON ED	EVA Pacer Wagon	22,611	1.42	45,842	.91
AT&T, CA	GMC BE Van	59,616	2.85	49,660	2.19
AT&T, MI	GMC BE Van	28,127	1.96	64,867	1.99
WED	Jet Ind. 100P Truck	1,351	2.07	5,760	1.29
APS	Jet Ind. 100P Truck	3,616	1.28	1,436	.91
APS	Jet Ind. Electrica			10,624	.80
LES	JMJ Electric Omni	430	.71	3,817	.76
ITT	SCT/Van			1,919	1.34
LES	EVA Current Fare Sedan			2,459	1.02
SWRI	Jet Ind. 1000 Van	2,268	1.22	9,904	1.36
SWRI	Jet Ind. 750 Truck	717	1.34	5,304	1.13
SWRI	Jet Ind. 1400 Van	264	1.09	5,194	.93
SWRI	JMJ Electric Omni	91	.64	2,446	1.16



Lincoln Electric System

LES.com